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EDITED BY

COLONEL W. H. HORROCKS, K.H.S.

ASSISTED BY

LIEUT.-COLONEL D. HARVEY, R.A.M.C.

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Original Communications.

PROTOZOOLOGICAL RESEARCHES, INCLUDING INVESTIGATIONS ON THE SAND IN EGYPT, UNDERTAKEN TO ELUCIDATE THE MODE OF SPREAD OF AMŒBIC DYSENTERY AND THE FLAGELLATE DIARRHŒAS: WITH CONCLUSIONS REGARDING THE SANITARY MEASURES NECESSARY TO PREVENT THESE DISEASES.

By Captain DAVID THOMSON.
Royal Army Medical Corps.
AND
Captain J. GORDON THOMSON.
Royal Army Medical Corps.

CONTENTS.

(*a*) PREFATORY NOTE.

IN our attempts to elucidate the mode of spread of amœbic dysentery and the flagellate diarrhœas, we have made investigations from several points of view. It was necessary to trace the fate of the pathogenic protozoa passed in the excreta of human patients and to find whether or not they had any active or passive phase of life outside the human host in water, in sand, or in flies. In consequence many questions arose as follows : Had the pathogenic amœbæ or flagellates any active phase of life in water or in moist sand? If they had only a cystic phase of life outside the human host, how long did their cysts live in external conditions? When infective fæces dried up, were the cysts capable of resisting drought to such an extent that dry sand and dust might be infectious? Did flies which bred out of infective fæces contain any phase of these protozoa, or did flies which alighted and fed on such fæces carry the germs to food? In the course of our attempts to solve these problems we had frequently to examine the sand, concerning which many strange and unexpected facts came to light. Numerous species of protozoa, including harmless amœbæ and flagellates, were found to exist in the dry sand of Egypt, and some of these appeared at times in the fæces of patients. These had to be investigated, and though eventually we concluded that the great majority of them are quite harmless, nevertheless their study has thrown a certain amount of light on the problem of sand contamination in general. In view, therefore, of the wide scope of this research we have found it necessary to write this paper under eight headings, of which the first four have only an indirect bearing on the subject.

Sections V, VI and VII should, however, be considered more carefully, since from them we have based our conclusions regarding sanitation.

(I) General Observations on the Protozoa found in the Sand of Egypt.

In July, 1915, an investigation was commenced by Lieutenant-Colonel Sir Ronald Ross and one of us (Captain D. Thomson) at a General Hospital, on the mode of spread of amœbic dysentery. Dysenteric stools were deposited on the ordinary dry, sun-baked Egyptian sand in covered trays. These were examined daily by the microscope, to ascertain what happened to the pathogenic amœbæ and their cysts, under more or less natural conditions. On the third day there invariably appeared in the fæcal deposits swarms of amœbæ and flagellates. It was found, however, that these protozoa did not originate from the stool itself, but from the sand on which it was deposited. This was rather a startling discovery, for though these amœbæ and flagellates were not of the pathogenic species, nevertheless it showed that protozoa of the same class did exist in the sand, which was dry during the greater part of the year. Lieutenant-Colonel Ross left for England and further researches were carried on by the authors in the Central Laboratory under the directorship of Major Ferguson, R.A.M.C. At this time several of the sand protozoa had been noted to occur occasionally in the fæces of patients and, on this account, we considered it advisable to continue further investigations in this direction. We have eventually come to believe that the majority of the protozoa found in the sand are harmless; nevertheless, the whole subject has an important bearing on the question of sand contamination and leads up to the more important problems regarding the spread of the truly pathogenic amœbæ and flagellates, considered in the later sections of this paper. With regard to all diseases it is necessary to know the part played by the soil, if any, in harbouring the pathogenic germs in question. Much work has been done on this subject with regard to typhoid, anthrax, tetanus, etc., but little or nothing has been done in connexion with the pathogenic protozoa. We have, on this account, investigated the sand of Egypt because in the inhabited areas it receives an enormous amount of fæcal contamination, much of which is infective. It is therefore necessary to ascertain how long, or whether at all, the sand contaminated with such excrement is

dangerous. We are so far unable to cultivate the pathogenic intestinal protozoa in the test-tube and, for this reason, it is much more difficult to ascertain how long they live in sand or soil contaminated with infective fæcal matter. Our investigations, however, have shown that an enormous number of protozoa lie latent in the dry sand in cystic form and that these have great powers of resistance to drought. As already stated, the vast majority of these free-living sand protozoa appear to be harmless, but their presence is sufficient to show that this class of organism is quite as resistant to external conditions as most of the bacterial group. We have been careful not to assume that because the cysts of the free-living protozoa are very resistant to external conditions, the pathogenic species must have similar powers. It is likely that the cysts of the latter are much more delicate. Nevertheless we have obtained sufficient evidence, quoted in the latter part of this article, to show that fæcal contamination of the sand, more especially around populous districts, should be avoided as much as possible. Amœbic dysentery and the flagellate diarrhœas will undoubtedly remain endemic and continue as a scourge until great reforms have been made in the disposal of fæcal matter. There are few tropical countries in the world in which diarrhœal attacks are so common as in Egypt. So common have these attacks been amongst our soldiers, that they have become popularly known as attacks of "Egyptian tummy." They are liable to occur again and again in the same individual, especially during the hotter months of the year. In a thoroughly sanitated tropical area, like, for example, the Panama Canal Zone, such attacks are almost unknown. We are strongly inclined to believe that they are due to imperfect sanitation and that the so-called chill is a very secondary causal agent. The following is a summary of the investigations carried out by Ross and Thomson (1915) on the sand.

(*a*) Numerous protozoa exist in the dry sand of Egypt in the form of cysts or spores. They occurred in almost all samples of sand examined.

(*b*) They are more numerous in sand contaminated with horse-dung and fæces than in clean sand, and very few are found in the wet sand on the sea-shore.

(*c*) Some of the sand protozoa (*Amœba limax*), two small biflagellates and an infusorian, grow well and multiply rapidly in moist fæces. These are also found in fresh horse-dung and are evidently able to live and multiply in the intestine of the horse.

(*d*) These protozoa also multiplied rapidly when the sand was

moistened with bouillon and they grew profusely on moist nutrient agar.

(*e*) Other kinds of protozoa developed after some days when water was poured over the sand in a glass bowl exposed to the light.

(*f*) The protozoal cysts or spores exist in the sand from the surface to a depth of three feet.

(*g*) They are not killed by a prolonged period of constant drought and exposure to the powerful rays of the Egyptian summer sun, and this applies to those which exist even near the immediate surface.

(*h*) These sand protozoa are for the most part free-living aquatic organisms, but some of them are capable of living a parasitic life in the intestine of man and animals. Fæcal matter is a great aid to their rapid growth and multiplication in the free state.

(*i*) The cysts and spores get into the dry sand by fæcal contamination from man and animals (especially the horse). They are also carried there by the wind from the dried-up beds of canals, ditches and water pools.

As a result of our further researches we are able to add some additional interesting information to the above as follows:—

During the months of December and January a considerable amount of rain fell, and rain pools were often formed in the sand. These pools, however, did not give the sand protozoa sufficient time to hatch out of their cysts and multiply unless they remained for some four days or longer, which was a very rare occurrence. This shows that the sand protozoa cannot depend much on the rainfall in Egypt for their growth and multiplication. A sample of apparently clean dry sand, taken near the Great Pyramids, developed numerous amœbæ and flagellates when moistened with sterile bouillon. These developed similarly from a sample taken near the Assouan quarries. They also occurred in large numbers in sand taken from the dried-up bed of the Nile, near Assouan. In a clean dry specimen of sand from Luxor, however, they were found only in very small numbers. In these latter parts of Egypt there is practically no rainfall, so we can only conclude that the protozoal cysts lying passive in the sand have been blown there from the dried-up banks of the Nile and the irrigation canals, and some may represent fæcal contamination. Again we are forced to conclude that these cysts have extraordinary powers of resistance to drought. When dry sand is examined microscopically it is very difficult to recognize the protozoal cysts in it. They are usually so very opaque and shrivelled that it is extremely difficult to distinguish them from the

sand grains. One should not be too ready to jump to the conclusion, therefore, that a protozoal cyst is dead when it has become shrunken and opaque due to the influence of drying.

(II) Observations on the Life-cycle and Habits of the *Amœba limax* found in the Sand.

We have studied this amœba very carefully, not because we believe it to be pathogenic, although it sometimes inhabits the human intestine and has a strong affinity for human fæces, but because we consider that a full knowledge of its life-history might throw light on the amœba class in general, and that thereby we might be enabled to deduce important inferences with regard to the truly pathogenic *Entamœba histolytica*. This latter amœba has so far baffled all attempts at cultivation, and hence is much more difficult to study than the *limax* type which is easily grown on artificial media. The cysts of *A. limax* are easily obtained and their viability easily tested, whereas those of *E. histolytica* or *tetragena* are not always found in abundance and experiments to test the viability are tedious and difficult. Moreover, the complete life-history of *E. histolytica* cannot yet be considered as fully worked out. In fact, there is considerable controversy and doubt with regard to the complete life-histories of even the very commonest free-living amœbæ, such as *A. proteus*, *A. limax*, etc.

The *A. limax* is a very widely spread organism and it is believed that there are many species of this amœba, all of which resemble each other closely. It occurs abundantly with other protozoa in the dry sand. It was found to be present more abundantly in places contaminated with human excrement and horse-dung, but in places where the sand is very clean we were unable to find it. This organism has also been found in abundance by Musgrave and Clegg (1904) in the soil of the Philippine Islands and also in the tap-water there. The observers cultivated it on many occasions from the human fæces and were even inclined to believe that it sometimes produced dysenteric symptoms. Other investigators, however, Walker and Sellards (1913), have since brought together a considerable amount of evidence which would appear to prove conclusively that it is non-pathogenic to man. While investigating this amœba we employed the following technique:—

(*a*) *Cultivation.*—A large drop of molten nutrient agar was spread over part of the surface of a sterile glass slide lying in a sterile Petri dish. After the agar had set, a small quantity of sand was placed on it and spread about the central area. It was neces-

sary to add a few drops of sterile water to the Petri dish to keep the agar from becoming too dry. These preparations were kept exposed to light at the ordinary laboratory temperature. In such a culture preparation there appeared as a rule on the third or fourth day a copious growth of *A. limax*, small biflagellates and infusoria. These organisms grew quite well at all temperatures, varying from 55° F. to 90° F., but the growth was more rapid and abundant during the hot weather (80° F. to 90° F.).

(*b*) *Staining.*—After a good growth had been obtained, the culture slide was immersed in Schaudinn's fixative fluid for ten minutes. It was then placed in distilled water for a few minutes and subsequently passed through fifty per cent alcohol to ninety per cent alcohol (twenty minutes in each). The film was then stained in Weigert's iron hæmatoxylin for fifteen minutes and decolorized with seventy per cent alcohol containing one per cent concentrated hydrochloric acid. The slide should be kept in the decolorizing fluid until the agar becomes transparent with a faint brown tint; about ten to thirty minutes is as a rule sufficient. The decolorization may be watched under the microscope. After immersing in water to remove the acid alcohol, the preparation is passed through fifty per cent, eighty per cent and absolute alcohol, about twenty minutes in each, and finally cleared in xylol and mounted in Canada balsam. Very beautiful permanent preparations of the whole cultures were obtained by this method. More perfect staining can be obtained by using Heidenhain's iron hæmatoxylin method, but this involves a long immersion in the mordant and staining fluids, and during the process the agar was very liable to wash away from the slide and get broken into fragments. We found it very difficult to make permanent stained preparations of the protozoa which developed in the mixtures of sand and water exposed to the light, as the sand containing the protozoa would not adhere to the glass slide, especially during the process of wet fixation and staining. The difficulty was, however, eventually overcome by mixing a drop of the wet sand with a drop of fresh human blood and smearing the mixture over the slide. These smears were stained by Giemsa or eosin-azur. For wet-fixed hæmatoxylin preparations the wet sand had to be mixed on the surface of the glass slide with molten agar and smeared out as thin as possible. It was difficult to get the flagellæ stained by the latter method, but these were well stained in the Giemsa specimens, so by using both staining methods the cytology of the various organisms was eventually obtained. Fresh preparations from the sand aquarium were also studied and direct observations were made on the living cultures with a high-power dry lens.

(*c*) *Description of the* Amœba limax *as seen in fresh-stained Preparations.*—In fresh films the amœbæ usually showed active movements progressing, as a rule, in one direction in a slug-like fashion. At other times they are more stationary, and are capable of throwing out long pseudopodia in various directions. This movement, in fact, varies according to the nature of the medium in which they are living. In deposits of fæces they showed atypical slug-like movement; in bouillon cultures and in water they showed often a more straggling movement. On the agar cultures they exhibited all varieties of shape, from round to extremely elongated and branched forms, depending on the amount of moisture present. On several occasions the slide cultures were immersed by adding sterile water to the Petri dishes. In this sudden change of environment the amœbæ may continue to move about actively; but, as a rule, they tend to become encysted. On one occasion practically all of the amœbæ in the culture became encysted after three days' immersion in water. This shows that cyst formation is something more than a mere provision against drought. When an agar culture of the amœbæ is placed under water, the amœbæ do not multiply so profusely. Those which were already encysted before the immersion may remain cysts, or these cysts may hatch out after a time, each producing a single amœba. The active forms may encyst quickly after immersion in the water, or they may remain active for many days. The actual growth of the amœbæ is whitish in colour. This growth, however, is always mixed with cocci or bacteria, since the amœbæ cannot be cultivated without the presence of one or other of these organisms. In the live cultures on agar the amœbæ on microscopic examination have a slightly greenish tinge, but in coverslip films containing a drop of water they appear greyish white and translucent. Often it is difficult to distinguish the ectoplasm from the endoplasm, except when pseudopodia are extruded. The nucleus is usually clearly seen, consisting of a dense round central mass of chromatin surrounded by a clear halo. The amœbæ are sometimes seen to contain a contractile vacuole, especially after the culture is immersed under water. Sometimes the endoplasm is seen to contain cocci and other ingested material within vacuoles, at other times the endoplasm is almost homogeneous or finely granular. In Giemsa-stained films the amœbæ are seen to vary considerably in size from about five microns to twenty-five microns in diameter. The whole protoplasm may stain bluish, but sometimes the ectoplasm may show a reddish tint. Sometimes the protoplasm

contains much ingested material, and is highly vacuolated; at other times it is comparatively homogeneous. The nucleus, as a rule, is seen to consist of a red-staining reticulum with blue interstices, more rarely it shows a homogeneous bluish centre with a red margin. Specimens prepared by wet fixation (Schaudinn's fluid) and stained with hæmatoxylin (figs. 1 to 9, Plate I), measure from ten microns to twenty microns in diameter. They show, as a rule, a finely reticulated protoplasm with no demarcation between endo- and ecto-plasm. The nucleus is always a very definite structure consisting of a central homogeneous circular mass of chromatin surrounded by a clear halo, which in turn is bounded by a thin dark line. From stained cultures it was clearly seen that the amœba is capable of multiplying in two ways. The most common way is by simple division of the cell into two daughter cells (figs. 1 to 5). More rarely, however, the nucleus is capable of splitting into four or more portions, and then the cell splits up into four or more daughter amœbæ, or, in other words, they may multiply by a kind of imperfect schizogony (figs. 6 to 9). In the deposits of stools on sand it was observed that the *limax* amœbæ were at first large and active. Day by day, however, their size and activity diminished as the medium became exhausted. Eventually their size dwindled to from five microns to ten microns, and finally they became encysted. In the agar cultures the round inactive and cystic forms are found in the centre of the growth and the large active vegetative forms at the margin. Sometimes the cysts are seen to be more or less surrounded by the active vegetative type (*see* fig. 10, Plate I). At the margins of the growth on the agar ovoid or cigar-shaped masses frequently occurred. These varied in size very markedly. Some seemed to consist of masses of granules, probably cocci, while others appeared to be full of amœbæ (figs. 11 and 12). At first we were inclined to believe that these represented some peculiar phase in the life-history of the amœba, but later we came to the conclusion that they were crumpled masses of cocci, into which masses the amœbæ crawled and multiplied until they occupied the whole mass. In any case these cigar-shaped masses of amœbæ are very puzzling both in fresh and stained specimens.

(*c*) *Evidence for and against Sporogony within the Cysts.*—The cysts of *A. limax* vary in size from about five microns to ten microns in diameter. In fresh specimens they as a rule show one distinct nucleus with granular protoplasm around it and a definite cyst wall with double contour. The cyst wall is sometimes very

thick and when very dry the whole cyst may show an irregular and shrivelled outline. In cultures the cysts often show an appearance which would lead one to believe that sporulation was occurring within them, and as small flagellates were almost invariably present in the moist cultures, we suspected that these cysts might probably hatch out into minute flagellates as is believed by certain observers.

In order to ascertain this, we immersed live cultures containing numerous cysts under a shallow layer of water and watched continuously those which appeared to have spores within them. On two occasions we noted suddenly great activity within the cyst and minute bodies were violently ejected until the cyst was quite empty. Here we apparently had evidence that the cysts were capable of splitting up into minute actively motile bodies, but the weakness of the evidence lay in the fact that these cultures which were made direct from the sand were impure and contained amœbæ, flagellates, infusoria, and mould spores. It was the mould spore complication which made us doubtful, since a species of mould was present which produced spores almost identical with the amœba cysts, and it is known that certain of these fungi have complicated life-cycles involving the production of minute flagellate bodies. In order to avoid this complication we proceeded by sub-culture methods to obtain a pure culture of the amœba plus a bacterium or coccus, but free from moulds and other protozoa. We eventually managed to obtain this and immersed this culture under water and watched the cysts very carefully as before. This preparation was watched at intervals during a period of fourteen days, but the phenomena seen in the impure cultures were absent. Many of the cysts showed the appearance of sporulation, but on watching these for a long time a single amœba containing large highly refractile granules eventually emerged. In this preparation we watched amœbæ encysting and also hatching out from these cysts. The recent cysts were finely granular, but later changes, apparently nuclear, took place within them and they began to show an appearance like sporulation. Eventually slow amœbic movement took place within the cyst wall, a contractile vacuole appeared and a single amœba finally emerged. No flagellates of any kind developed in the submerged culture, which remained pure during a period of fourteen days, after which a stained preparation was made. This experiment, therefore, threw grave doubts on our previous evidence in favour of sporogony. The stained cysts (figs. 13 to 20) show a definite double contour; the outer contour is often irregular,

especially if the cysts have been dried for a considerable time. As a rule the cyst shows one typical central nucleus (fig. 13), very rarely two nuclei are seen (fig. 14). We believe that figs. 13 and 14 represent recently formed cysts; in the later stages nuclear changes take place (*vide* figs. 15 to 19), in which the chromatin of the nucleus splits up. It may be that "chromidia" are formed; at any rate the chromatin consists of a central mass surrounded by a dark ring which eventually breaks up into further masses of chromatin, so that finally we have a ring of chromatin particles surrounding the central portions. What these changes represent we are at present unable to explain. Autogamy or sporogony may occur, but we cannot be certain that they do take place. Fig. 20 shows what might be sporogony within a cyst. Figs. 21 to 26 represent what appear to be masses of spores as seen in stained preparations of impure cultures of *A. limax*. Whether these sporing bodies have any connexion with the amœbæ we are unable to state. Fig. 27 represents a type of mould spore which occurred frequently in these culture preparations. In fresh specimens these mould spores are sometimes difficult to distinguish from the amœbæ cysts, but often their true nature is disclosed by the presence of budding. Sporulating bodies (figs. 28 and 29), similar to those found in the cultures, were also found frequently in the sand aquarium, both in fresh and stained preparations. Fig. 30 shows the free spores. In fresh films these spores were always motionless. Figs. 31 and 32 were also seen frequently in stained films from the sand aquarium. Certain observers state that a species of parasite sometimes attacks the *A. limax*. This parasite forms spherical masses of spores within the cytoplasm of the amœba (vide *Archiv für Protistenkunde*, Band vi, S. 196, figs. 9 to 12, also Band xvii, S. 3, fig. 1). We have been unable to confirm these observations. Figs. 33 to 37 (Plate I) appear to represent amœbæ containing bodies of some kind. These were found in one of our impure cultures. We are inclined to believe that cysts of *A. limax* do not as a rule sporulate or give rise to flagellates, Definite sporing forms as brought out by staining were seldom seen. Since, however, it is known that there are several species of this amœba, it may be possible that the cysts of some species form spores while those of the others do not.

(III) Protozoa and other Organisms found in the Sand, which also occur at times in the Human Fæces.

In a country like Egypt, where sand frequently blows about and gets into the mouth and into food, it is not surprising that one should often find in the fæces organisms which exist in the sand as cysts or spores. The converse applies equally well, viz., that it is not a surprise to find in the sand, organisms which multiply abundantly in the human intestine and are passed out in large numbers in fæcal matter and thereby deposited on the sand. We have been strongly impressed by the extraordinary degree of contamination of the sand in Egypt, more especially in and around the large towns. The whole sea-front of A extending for some three miles can be looked upon with justice as a vast latrine for the native population. This sand has been polluted for centuries. The fæcal material dries up quickly, and the surface sand is blown far and wide by the winds, and many of the fæcal organisms thus find their way back to the human intestine. Plate II shows the organisms which we have found both in the human fæces and in the Egyptian sand. The spirochætæ shown in figs. 38 to 40 are frequently found in the fæces, especially in diarrhœal conditions, and when a mixture of water and sand is kept in the dark these same spirochætes develop in enormous numbers. Those represented in figs. 41 and 42 are also found in mixtures of sand and water, and they occasionally occur in the fæces as well. We have found vegetable filaments and diatoms as depicted in figs. 43, 44 and 45 in the fæces of dysenteric patients on two occasions. These develop always in mixtures of sand and water exposed to the light for some weeks. It is very difficult to explain how they got into the fæces, unless we suppose that the patients had swallowed some stagnant water containing them. Fig. 46 represents a mould commencing to sprout; such a figure is frequently seen in human fæces and also in sand agar cultures. Fig. 47 is some vegetable organism rarely found both in the sand and in the fæces. The organism depicted in fig. 48 was frequently found in our sand aquarium. It varied considerably in size, some being much smaller than that shown in the figure and some larger. A similar organism was found in considerable abundance in the fæces of three dysenteric patients, but we consider that its presence was accidental and not pathogenic. Fig. 49 represents a vegetative form of *A. limax*, already fully described. This amœba was found in considerable numbers along with the patho-

genic amœbæ in three patients suffering from dysenteric symptoms. The remaining organisms, figs. 50 to 57, were not actually found directly in the fæces on microscopic examination, but they appeared in numbers after the fæces had been kept moist for some days in a sterile Petri dish. This may be taken to indicate that they existed in the fæces in small numbers, probably as cysts, or else that the sand had got into the bed-pan after the fæces had been passed. They have also been obtained from fresh horse-dung not contaminated with sand. Like *A. limax* they grow well on moist nutrient agar or in sand moistened with bouillon. Fig. 50 represents a species of *balantidium* or *nyctotherus*, of which figs. 51 and 52 are the cystic phases. Smaller mononucleated cysts of this organism also occur. It will be noted that the cyst eventually splits up into four daughter cells and thus the active forms vary considerably in size. In agar cultures of this protozoan these phases are clearly seen. Conjugation and chromidiogamy are also frequently observed. Figs. 53 and 57 show two types of biflagellates cultivated from sand and also from human fæces. Figs. 50, 53 and 54 show a macronucleus but no blepharoplast and belong to the genus *Bodo.* Fig. 55 represents their cystic stage, which is uninucleate. Figs. 56 and 57 show a similar biflagellate possessing a blepharoplast and therefore belonging to the genus known as *Prowazekia.* These small biflagellates are very liable to be mistaken for *Cercomonas hominis* (vide Wenyon, 1915). We have drawn attention to these organisms found both in sand and fæces, not because we believe that they are pathogenic or even harmful, but only to emphasize the fact that organisms from the sand get into the human intestine and also that the organisms from the intestine get into the sand, so that in badly sanitated areas a kind of vicious circle is established between the two. This certainly occurs to a marked degree in the case of horses. Horses ingest large quantities of sand into their large intestine, and there the *A. limax*, *Bodo*, *Prowazekia* and *Balantidium* from the sand multiply and are passed out again in increased numbers. In this way horse-dung and human fæcal matter intensify the numbers of these protozoa in the sand. It can be truly stated, therefore, that the sand adds to the organisms in the intestine and that the fæces increase the organisms in the sand.

(IV) Other Protozoa in the Sand which so far we have not found in the Human Fæces.

In order to make this paper more complete we consider it useful to give a short account with two plates of most of the other protozoa which we have obtained from the dry sand. These were obtained from a single pint of apparently clean sand taken in front of the General Hospital. Part of this sand was planted on agar, and the remainder mixed with sterile water, which was left exposed to the light for several months. Some protozoa grew more abundantly when glucose was added to the mixture of sand and water. Figs. 58, 59 and 60, Plate III, represent stages in an organism which resembles *Striatella interrupta, vide* Thome (1907). This organism resembles a wheel or striated disc. The disc is rigid in nature and apparently contains an amœba-like body. It varies considerably in size, and forms only one-quarter of the diameter of those depicted are frequently seen. The whole structure is capable of dividing into two as seen in figs. 59 and 60. Figs. 61 to 65 show different forms and sizes of amœbæ which we found in the sand. Whether these are all different, or whether they only represent stages in the same amœba we are unable to state. Figs. 61 and 62 most likely represent the young forms of a larger species. Figs. 63 and 64 may be types of *A. limax*. Fig. 65, however, is too large for *A. limax*. *A. proteus*, which is much larger than any of those depicted, was occasionally found, also types corresponding to *A. verrucosa* and *A. diploidea* were frequently obtained in fresh and stained specimens. Another type (fig. 67) was very rarely seen in the sand aquarium. This species was quite different from all the others in that the cytoplasm was filled with highly refractile oval bodies. It moved actively in a slug-like fashion. Many flagellates were found. The species shown in fig. 66 flourished particularly well when water plus glucose was added to the sand. This flagellate showed at times a capacity for amœboid movement, and it may be connected in some way with the amœba last mentioned, since, like it, the cytoplasm is filled with refractile oval bodies. It apparently belongs to the order Euglenoidina and resembles *Astasia margaritifera* (*vide* Henri Coupin, "Les Algues du Globe.") We found also a green flagellate, fig. 71, containing chlorophyll and a red pigment spot; a greenish amœba resembling this organism minus the flagellum was also observed. Other chlorophyll-containing organisms (figs. 68, 69 and 70) were found in the sand aquarium. Fig. 68 represents *Scenedesmus caudatus*, and figs. 69 and 70, which are stages of the same organism, *Pandorina morina*

(*vide* Oltmann, 1904), were exceedingly abundant. Figs. 72 and 73 were frequently found in our sand aquarium. The former apparently belongs to the class Rhyncho-flagellata. The body had a watery gelatinous-like appearance, and it moved about slowly in a revolving or tumbling fashion. The organism depicted in figs. 74 and 75 grew abundantly when the sand was moistened with bouillon. It was found especially abundant in samples of sand taken near the Great Pyramids at Gizeh. It possesses four flagella and a large cystostome, and might very easily be mistaken for *Trichomonas hominis* and *Tetramitus mesnili* which occurs in the human intestine (*vide* Wenyon, 1915). The large flagellate represented in fig. 76, Plate IV, was found rarely in our sand aquarium, that shown in fig. 77 was also very scarce. Fig. 78 was frequently found and also the ciliate shown in fig. 79. The latter always showed three nuclei in the stained specimens. The ciliate depicted in figs. 81 and 82 was found in abundance and had a curious habit of remaining absolutely stationary for a long time, then suddenly darting off again. It resembles to some extent *Maupasia paradoxa* (*vide* Minchin, 1912). It has a well-defined retractile vacuole and a large flagellum at the posterior end. The nucleus in fig. 82 appears to be capable of splitting up into several portions. The ciliate (fig. 83) was found frequently in the sand aquarium and fig. 80, *Euplotes harpa*, was quite common and was able to multiply in moist agar cultures in conjunction with *A. limax* and *Bodo* on which it fed. Other ciliates were found—viz., *Paramæcium caudatum* and *Coleps hirtus*. Figs. 84 to 93, painted from stained preparations from the sand aquarium, probably represent stages in protozoa belonging to the class Sporozoa. Finally, figs. 94 and 95 represent a minute organism (possibly a small flagellate) which appeared in enormous numbers when glucose water was added to the sand. No doubt many of these organisms are well known and have been fully described, but owing to the difficulty in Egypt of obtaining a complete literature of the protozoa we have been unable to identify and name many of the species which we have found. The following table is a complete list of the organisms and other than bacteria which we have obtained from the Egyptian sand.

(*a*) Spirochætes.	Seven varieties.
(*b*) Vegetable.	(1) Diatomaceæ. Many kinds, including— *Striatella interrupta.* (2) Ulothrichaceæ— *Ulothrix zonata.* *Acanthocystis aculeata* (?). (3) Scenedesmaceæ— *Scenedesmus caudatus.* (4) Moulds. Many varieties.

(c) Protozoa.

(1) Sarcodina—
- *Amœba limax.*
- „ *proteus.*
- „ *verrucosa.*
- „ *diploidea.*
- Two other species not identified.

(2) Actinopoda (?)
- One specimen not identified.

(3) Mastigophora—
- *Bodo.*
- *Prowazekia.*

Flagellata—
- *Astasia margaritifera ?*
- *Euglena quartana ?*
- *Pandorina morina.*
- Five other species not identified.

Rynchoflagellata. One species not identified.

(4) Infusoria—
- *Paramœcium caudatum.*
- *Coleps hirtus.*
- *Maupasia paradoxa ?*
- *Euplotes harpa.*
- Four other species not identified.

(5) Sporozoa.
- Several species not identified.

(V) The Viability of the Cysts of the Free-living Amœbæ, Flagellates and other Protozoa in the Sand.

(*a*) *Powers of resisting Drought.*—All of the free-living protozoa mentioned above were obtained from a pint of very dry sand, after a period of about eight months of continuous drought. A box of this sand was taken to England by Lieutenant-Colonel Sir Ronald Ross and *A. limax* and flagellates were cultivated from it in London.

Celli and Fiocca (1894) found that the cysts of *A. limax* could resist drying from eleven to fifteen months, and Miller (1894) states that they can resist drying for six years. There can be no doubt therefore that their resistance to drought is very great indeed.

(*b*) *Resistance to Sunlight and X-rays.*—The place from which we took our sand for cultivation purposes was exposed for many hours daily to the glare of the sun; moreover, it was taken quite close to the surface, not more than an inch down. Sand taken from the surface of a sun-baked road invariably gave a good growth of amœbæ and flagellates on agar. Musgrave and Clegg (1904) state that the cysts of *A. limax* are not killed by twenty minutes' exposure to X-rays and even cultures of the active amœbæ were found to be still alive and moving after two hours' exposure to sunlight.

(*c*) *Resistance to Heat and Cold.*—Musgrave and Clegg (1904) found that *A. limax* were still alive after being frozen to 12° C. for a period of forty-five days; on the other hand, a temperature of

60° C. for one hour did not always kill them. We found that they were rapidly killed from the sand by boiling with water or by roasting.

(*d*) *Resistance to Chemicals.*—Musgrave and Clegg (1904) state that cysts of *A. limax* are not killed by a solution of 1 in 2,500 quinine applied for ten minutes. Similarly they survived a solution of 1 in 1,000 formalin for five minutes. Frosch (1897) found that the cysts of his *A. nitrophilia* could resist a twenty per cent solution of sodium hydroxide for seventy-two hours.

(*e*) *The Effect of placing the Cysts in Water.*—No doubt the usual result of placing protozoal cysts in water is to cause them to hatch out into the free-living forms. This is apt to give rise to the idea that protozoal cysts are merely resting stages of the free forms whose chief function is to tide over a period of adverse conditions, more especially drought. Our researches on the sand organisms, however, have shown that the cysts are something more than that. Cysts actually form in water when there is no drought and in water they may remain as cysts for at least some days. Again, several of the cysts of these free-living protozoa have a reproductive function, in that two or four daughter organisms are produced within the cyst wall and these eventually hatch out into the water (*vide* figs. 50 to 52, Plate II). It is well to remember, therefore, that a cyst need not necessarily hatch out in water for some time, and that, on the other hand, the free active forms of protozoa may actually encyst in water.

(*f*) *Experiments on the Sterilization of Water and Sand Mixtures containing the Free-living Protozoa.*—Lieutenant-Colonel Buchanan suggested that we should carry out several experiments in order to find whether or no the cysts of the free-living protozoa would be killed out of a mixture of sand and water by the addition of the usual chemicals employed for sterilizing water in the Army. The results of these experiments were as follows:—

(1) Fifty cubic centimetres of sand were added to one gallon of water. To this 0·2 gramme of chloride of lime (ten times the relative dose used to sterilize water in the army carts) was added. The mixture was stirred up thoroughly and after twelve hours some of the sand was transferred to an agar plate by means of a platinum loop. Result—a profuse growth of *A. limax*, flagellates and infusoria after seven days.

(2) The same experiment was carried out with potassium permanganate, sixty grains to the gallon. In this case only flagellates appeared in the culture.

(3) Acid sodium sulphate, twenty grains to the pint, acting for twelve hours failed to kill the free-living amœbæ, flagellates, or infusoria from a mixture of sand and water.

It must be admitted therefore that the cysts of the free-living protozoa are exceedingly resistant to all kinds of adverse conditions. The only satisfactory way of killing such cysts in sand or water, or in a mixture of the two, is roasting or boiling.

(VI) Experiments on the Viability of the Free and Cystic Forms of the Pathogenic Intestinal Protozoa outside the Human Host.

Unfortunately, no one has been able so far to cultivate the pathogenic intestinal protozoa, and in consequence their viability is not easily tested with any degree of certainty. It might eventually be gauged with considerable difficulty after a large number of feeding experiments on man and animals, but so far this has never been done. We have, however, made the following microscopic observations which, we think, may be of considerable assistance and value.

(*a*) *Trichomonas hominis.*—The cysts of these flagellates have not yet been definitely identified. A portion of a stool containing active *Trichomonas* flagellates was mixed with sterile sand and water and placed in the incubator at blood-heat. Next day no active flagellates were found. In a specimen kept at room temperature they similarly disappeared. Some observers have stated that they have found *T. hominis* free and active in the water of wells and tanks. We consider that this is doubtful, since we have found a free-living flagellate (Plate III, figs. 74 and 75) in sand-contaminated water, which might easily be confused with the somewhat similar intestinal species.

(*b*) *Lamblia intestinalis.*—A portion of a stool containing numerous *Lamblia* cysts was mixed with sterile sand and water and kept at laboratory temperature. No active flagellates hatched out from these at any time. Definite cysts were found after nine days and on staining they showed no signs of degeneration. The preparation was then allowed to dry up and some cysts were found microscopically two months later, though altered in appearance. We noticed that *Lamblia* infections were apparently more frequent in patients quartered in marquee tents with a sandy floor than in those quartered in the hospital proper. We have found no evidence that the free, active forms of *L. intestinalis* can live

outside the body or that the cysts which are passed in the fæces can hatch out in water.

(*c*) *Entamœba histolytica or tetragena.*—In freshly passed dysenteric stools the pathogenic entamœbæ are frequently seen moving actively, but they very rapidly become motionless unless the stage of the microscope is kept warm. After a few hours in a warm climate they die and rapidly disintegrate, possibly because they are overcome by the excessive multiplication of bacteria which causes them to autolyse. The only satisfactory way of obtaining actively motile entamœbæ is to examine a stool immediately after it has been passed into the bed-pan. When urine is mixed with the fæces, as often happens, the entamœbæ are rapidly destroyed. The cysts are much more resistant than the active or motile forms, but the life of these cysts depends on several conditions. If a fluid stool containing cysts of *E. tetragena* is kept in a test-tube, the cysts disappear in about two days, probably due to the destructive action of the rapidly multiplying bacteria. For this reason we were inclined to believe that cysts would not persist for any length of time in water. Colonel Wenyon, however, pointed out to us that if the fæces containing cysts were put into a large quantity of fresh water they persisted for many days quite unchanged. We have repeated this experiment and have found *tetragena* cysts quite unchanged in water after twenty-five days. This suggests that amœbic dysentery may be transmitted by drinking water collected from areas contaminated by fæcal deposits. In solid stools, not allowed to dry too much by keeping them in a corked bottle, we have found that the cysts of *E. tetragena* and *E. coli* persist for a month quite unchanged. It is therefore obvious that fæces kept in shaded places in a moist atmosphere might remain infective for a considerable period. In dry, sun-baked areas we noticed that fæces became hardened, and if we allow fæces containing cysts to dry up on sand the cysts become opaque and shrunken in appearance, so that it is impossible to make out their internal structure. It is possible in this case that the cysts are rapidly killed on the outer surface of the fæcal deposit. If, however, a stool exposed to the drying influence of the sun is cross-sectioned it is found that there is often a moist centre in which unchanged cysts can be found. Fæces, therefore, buried below the surface of the ground or protected from excessive drying may retain their infectivity for several weeks. Although the cysts of the free-living protozoa—for example, *Amœba limax*—resist drying to an extraordinary degree, we are inclined to think

that the pathogenic cysts are destroyed when completely dried in the sun. This, however, is a point which requires further proof. It is quite obvious in any case that we must not trust to sunshine and drying in this matter, since fæces deposited in the open are at once attacked and devoured by swarms of flies. We shall presently show that the live cysts are carried away in this manner and so the damage is done before the drying takes place.

(VII) Methods by which these Cysts are carried from Man to Man.

We have already shown that the active forms of *Entamœba histolytica*, *Trichomonas hominis* and *Lamblia intestinalis* do not live outside the body or pass any active phase of their existence in water. It has been shown by Colonel Wenyon, moreover, that the motile phase of the pathogenic amœbæ is not infective by the mouth. In consequence, we may be sure that these diseases are not transmitted by the active forms. It has been proved, however, by many observers that the cysts are infective when swallowed and produce true amœbic dysentery. The cystic phase is the sole cause of the transmission, and we have just pointed out that these cysts are able, under favourable circumstances, to live for at least a month outside the body. It need hardly be stated, therefore that patients who pass pathogenic cysts in their fæces are highly dangerous to the community. In another communication we have pointed out that in cases of acute amœbic dysentery, where much blood and mucus is present, cysts are seldom found. In cases, however, where the disease has become latent or chronic, cysts are often passed in the fæces in great numbers. Such patients may be comparatively well and carrying on their daily work as usual. In other words, there exist ambulant cyst carriers of amœbic dysentery. We also found that imperfect treatment of the acute and sub-acute stages of the disease, with only one to four grains of emetine, tended to bring about this dangerous condition. It is highly important, therefore, to treat all cases thoroughly. Never less than twelve grains of emetine should be given in one continuous treatment of one grain daily. Further research on this subject is tending to prove that even more than this is necessary. When a patient is found to be passing cysts, he should be given even a more thorough treatment combined with saline purges. As a rule seven to eight grains of emetine combined with salines will eliminate all the cysts, but sometimes they are found to be much

more persistent. Colonel Wenyon and Dr. Low have observed this same persistence in spite of large doses. This is sufficient to show that all cases of amœbic dysentery, and more especially the cyst carriers, should be subjected to a very thorough course of continuous emetine treatment. We will now show how these cysts passed out in the fæces of one individual may find their way into the intestinal tract of others as follows:—

(*a*) *Direct Contamination of Food by the Fingers.*—A young kitten was fed on fish contaminated with fæcal matter from a cyst carrier. In fourteen days it developed blood and mucus in its stools, which when examined microscopically showed numerous entamœbæ of the pathogenic species. The kitten seemed ill, but became rather better a few days afterwards. No further blood and mucus was present. After thirty days the animal died. The post-mortem examination showed several small typical amœbic ulcers in the caput cæcum and several small ulcers in the rectum. One or two very small young ulcers were found midway between the caput cæcum and the rectum. The rest of the mucosa seemed quite normal. There was no abscess of the liver. This experiment proves, without doubt, that we were dealing with the pathogenic entamœba, and it is interesting since it demonstrates that it is quite possible for animals to become infected by eating food contaminated with cysts. The kitten ate the contaminated fish with great avidity, and no force was necessary, such as actual injection of the infective material through the œsophagus into the stomach. This shows that kittens could be naturally infected. It is easy to conceive how cysts may be deposited on human food by native cyst carriers acting as waiters or cooks, since they are not always cleanly in their habits. In hospitals it may similarly be carried by the fingers of orderlies, or nurses in attendance on patients suffering from the disease.

(*b*) *Contamination of Food and Water through the Agency of the Wind.*—One of us (J. G. T.) observed that when a soft or semi-solid stool was trampled into the sand, numerous small fæcal pellets were formed, each attached to sand grains. They were readily blown about by the wind. It is easy to conceive, therefore, how particles of highly infective fæcal matter (soft or semi-solid) can be carried about in this manner on to food and water and even into the mouth itself. On the other hand, a mixture of completely dried fæces and sand may or may not be infective. We have already shown that the cysts of the free-living amœbæ and flagellates live for a long time in dry sand and dust, so it would be as well to

consider dried-up mixtures of infected fæces and sand as dangerous until it can be definitely proved otherwise.

(*c*) *Contamination of Vegetables used as Food.*—We consider that the pathogenic cysts may be swallowed by eating fresh uncooked vegetables, since these are often manured with human fæces, more especially in Eastern countries.

(*d*) *Contamination of Food by Flies.*—One of us (J. G. T.) fed flies on fæces containing a large number of the cysts of *Entamœba tetragena*. Eighteen hours later these flies were dissected and on microscopic examination large numbers of these cysts were found in their intestinal contents. Colonel Wenyon and Captain O'Connor, working independently at this time, made more complete observations on this point and brought forward evidence to show that the cysts ingested by the flies and passed in their fæces were still alive. When ordinary house-flies caught in the laboratory were allowed to walk over sterile agar plates, we noted that moulds frequently grew from the track of their feet. Since these mould spores are often as large as *tetragena* cysts, one can conceive how the latter may similarly be deposited on food. There can be no doubt, therefore, that these diseases are conveyed to food by flies which have previously alighted on fæces containing cysts. We have noticed that flies seem to have a special affinity towards dysenteric wards. We have seen them alight in hundreds on sheets and clothing soiled with newly passed dysenteric fæces. The promptness with which flies will alight on even the smallest quantities of fæcal matter is astonishing. They constantly hover about the bed-pans of the patients and alight at once on any piece of soiled and exposed toilet paper. When one realizes that even a small speck of fæces the size of a pin's head may sometimes contain hundreds of cysts, it is not difficult to see how the disease is carried in this way. In fact, it seems highly probable that this is by far the most common and important mode of transmission. We have not yet examined maggots and flies bred out of infective fæces. On several occasions, however, we have hatched out maggots and flies of the sarcophagidæ group from portions of ulcerated dysenteric intestine. These maggots and flies were not found to contain any phase of the pathogenic amœba within them. There can be no doubt, however, that the flesh-breeding flies such as the blue-bottle, etc., can ingest the cysts from infective fæces and transmit them to human food in the same way as is done by the house-fly.

(*e*) *Contamination of Milk and drinking Water.*—Milk is con-

taminated by flies in the same manner in which they contaminate food. With regard to water, we have already shown that the cysts can live in it for several weeks, so that drinking water contaminated with fæces or fæcal sand is a source of infection.

(*f*) *Further Remarks.*—From these investigations it is clear that amœbic dysentery and the flagellate diarrhœas are infectious in the same degree as typhoid fever and the other intestinal diseases due to bacteria. It is quite probable that the cysts of the former diseases are more resistant to external conditions than the bacteria of the latter. The epidemic of amœbic dysentery which occurred in Gallipoli last summer abated very markedly in the late autumn, when the weather became cold, wet and windy. We believe that such a change in climate reduces the spread of the disease as follows:—

(1) Cold, wet and wind reduce very markedly the number of flies, and this was no doubt the chief cause of the cessation of the Gallipoli epidemic.

(2) Rain reduces the mechanical transference of fæcal sand particles, and much rain washes away most of the fæcal contamination from the soil.

(VIII) Conclusions regarding the Sanitary Measures necessary for the Prevention of Amœbic Dysentery and the Flagellate Diarrhœas.

It appears to us fortunate that our researches have led us to believe that the sanitary measures necessary to prevent these diseases are identical with those required to prevent the other intestinal scourges such as typhoid fever and bacillary dysentery. We will discuss these measures in the order of greatest importance.

(*a*) *Rapid and thorough Disposal of Fæces.*—As a general rule it may be stated with truth that our Army methods are thorough in this respect; nevertheless we venture to suggest some further improvements. It is absolutely essential that the fæces should be disposed of in such a way that they will not dry up and be blown about. In warm countries where there is much sand and drought, and in conditions of war such as where flies exist in myriads, this is most important. Fæces in such surroundings are covered with flies in a few seconds after they are deposited in the usual shallow or deep latrines, so that even if they are covered up with sand one minute later, it is, nevertheless, too late. In consequence some other method is necessary in such circumstances. The

construction of fly-proof latrines obviates this danger, but these are rather elaborate contrivances, and necessitate a quantity of wood being used, which is liable to become very foul and when the Army is on the move it is cumbersome to carry about. In our opinion the best method, short of instant destruction by cremation, would be a kind of kerosene bucket system. Latrines should always be kept scrupulously clean and attractive as possible, otherwise the soldiers will tend to avoid them and be tempted to defæcate in some other place of their own choice. We suggest that more attractive latrines with slight partitions should be built, and that the fæces should be passed into metal buckets containing kerosene, or some similar antiseptic which repels flies, because by this method the latter would have no opportunity of alighting on the fæces even for one second. The flies will avoid these buckets on account of the kerosene, and in consequence they will not alight even on the soiled toilet paper floating on the surface. It should be the duty of the sanitary squad attending to the latrines to add fresh kerosene to the buckets when necessary, and they should also set fire to the fouled toilet paper several times daily. Simple light metal seats would be better than wooden ones, as the former could be more easily kept clean, and even sterilized daily. The ground or sand around the buckets should be sprayed at intervals with crude oil in order to sterilize it and prevent it from forming dust and blowing about. Finally, a bucket of some antiseptic with soap and towels should be placed outside the latrine and a sentry specially posted there to enforce that the men wash their hands before leaving. At the end of each day the buckets should be emptied by the sanitary squad into deep pits and immediately buried, or better still the bucket contents should be burnt in a large and powerful incinerator along with horse-dung and other rubbish. The kerosene would be an advantage in this way because it is inflammable. The empty buckets must be sterilized before being replaced in the latrine, by immersing them for a few minutes in a huge metal cauldron of boiling water specially constructed for this purpose. Some kind of metal cart similar to a metal pontoon boat might be constructed for this purpose, and when the Army was on the march the sterile metal bückets could be packed in such carts. On the other hand, it is conceivable that the metal buckets and seats could be sterilized by means of a spray of superheated steam, such as is used in modern dairies for sterilizing milk pails, or a kind of blow-lamp, such as used by painters, would serve equally well. There can be no doubt that in some such way as this a more perfect

and reliable system of rapid and thorough disposal of fæces could be evolved, and even although it necessitated a larger sanitary staff and equipment, the results would undoubtedly repay tenfold this extra encumbrance and expense.

(*b*) *The rapid and thorough Disposal of Horse-dung.*—Horse-dung is not so dangerous as human fæces, because there is no reason to believe that horses harbour in their intestines the cysts of the human pathogenic protozoa. Nevertheless it is dangerous in that it attracts flies, and also because flies breed in it. Moreover, there is some reason to believe that it may be responsible for much of the epidemic jaundice which has occurred in E. and G. Horse-dung should therefore be collected daily and burnt. The burnt material is a valuable manure and might be collected as such. On no account should horse-dung be employed in the making of roads as is sometimes done.

(*c*) *The Destruction of Flies.*—This is highly important. The common house-fly lays its eggs in horse-dung, human fæces and refuse. These eggs hatch out into larvæ and eventually become adult winged insects. When therefore measures (*a*) and (*b*) are thoroughly carried out the destruction of flies is largely accomplished at the same time because their principal breeding places are destroyed. In addition, however, it would be advisable to employ several of the many methods recommended for the destruction of the adult winged insects themselves.

(*d*) *The Protection of Food, Cook-houses, Canteens and Mess-rooms by a thorough System of Screening.*—In spite of all endeavours to destroy fæces, dung, refuse and flies, it may be found, especially where the Army is situated in adverse conditions, or when it arrives suddenly in unhealthy native localities, that flies still abound. For this reason an additional system of protective screening should always be carried out to safeguard the food and mess-rooms of the soldiers. In stationary camps this must be considered as a measure of the highest importance. Cook-houses, canteens and mess-rooms should be rendered fly-proof by thorough screening. If possible there should be two fly-proof doors separated by an interval of a few feet, and these doors should close automatically by means of powerful springs. Punishment should be inflicted if the doors are wilfully left open, and a gang of carpenters should be sent round periodically to repair any damage done to the screening. This is done in the Panama Canal Zone in an extremely thorough manner by the American army engineers. It is especially important that the cooked food should not be contaminated by flies

before it is eaten. Where the screening system is considered absolutely impossible, the "arsenite bait" method recommended by Lieutenant-Colonel Charles Porter should be extensively used. Hang up leafy branches and spray them with "arsenite bait." Spray tent surfaces and hard wall surfaces with the same material and keep all food covered so that flies cannot alight upon it.

(*e*) *Separation of Army Camps from Native Habitations.*— If a well-sanitated army camp is situated close to an insanitary native town or village, there can be no guarantee that the troops will remain free from disease. Flies breeding in the native quarters will carry the disease germs from the exposed fæces of the natives to the food of the soldiers, and the sand contaminated with semi-dried-up fæcal matter may also be blown from the native area into the army camp. If possible, therefore, the camps should be situated at least one-half to one mile distant from any such unhealthy area. If this is impossible steps should be taken immediately to sanitate the native quarters near at hand, by destroying the dung-heaps, refuse and other fly-breeding material in them. The camps along the foreshore in A are infested with flies, not because the camp sanitation is bad, but because the flies breeding in the native quarters close by are attracted especially by the horses. These flies are breeding not only in the native quarters, but also in the fæcal matter littered along the sea-shore. As already stated the whole of the A shore abounds in native fæcal deposits. On one occasion we examined several of these microscopically and the first specimen examined showed *tetragena* cysts. This is sufficient to show that infective material is deposited daily on this shore, in many instances not more than twenty yards from the tents and mess-rooms of our soldiers. This dangerous native fæcal matter is transported by flies all over our shore camps to the food in the cook-houses and mess-rooms, since most of these are unscreened, or, at any rate, imperfectly screened. This is sufficient to show how camp sanitation alone may be quite inadequate in the prevention of the diseases in question. In A it is necessary to prevent the foreshore from being used as a latrine by the natives. The natives, however, must have some suitable place or places for defæcation. We suggest that the municipality should be urged to erect several public latrines at intervals along the sea-front, and thereafter it might be one of the duties of the numerous native and camp sentries posted along this foreshore to see that the natives used the proper places erected for them. An anti-fly campaign should be started at once in the native quarters by

destroying the dung and refuse heaps which abound in them. It is obvious, therefore, that the measure of pitching camps at a considerable distance from native dwellings is of the greatest importance with regard to the prevention of dysentery, typhoid fever and the flagellate diarrhœas. It is at the same time essential as a means of preventing malarial fever and other diseases.

(*f*) *Separation of Horse-lines from the Sleeping Quarters and Mess-tents of the Soldiers.*—The horse-lines should be situated about 1,000 yards from the soldiers' encampment. If this is utterly impossible they should be at least 100 yards distant, and not four yards away as has been noted in some isolated instances. It is possible that in this way epidemic jaundice might largely be avoided. Horses always attract flies, and this is one of the chief reasons for keeping them at a considerable distance from the quarters of the men.

(*g*) *Precautions with regard to Water Supply.*—If fæces are disposed of properly, the water supplies are not likely to become contaminated. With regard to suspected water, the usual method of chlorination, etc., renders it safe so far as typhoid, cholera and bacillary dysentery are concerned, but we do not know whether or not this is sufficient when the water is contaminated with fæces containing the pathogenic protozoal cysts. Our experiments showed that ten times the ordinary chlorination did not kill off the cysts of the free-living protozoa such as *A. limax*, etc., but we cannot argue from this that it will not kill those of the pathogenic protozoa, which are likely to be much more delicate in external conditions. Nevertheless, until this can be proved it would not be right to consider such a suspected water safe until it had either been filtered or boiled.

(*h*) *Sterilized Sand should be supplied for the cleansing of Mess-tins, etc.*—Sand can be sterilized easily by roasting it or boiling it with water. This sterilized sand should be kept in covered metal receptacles, and soldiers who are found using other sand for cleansing purposes should be punished. The sand all over E, and especially on the foreshore, is highly contaminated with fæcal matter. The sea-shore at C and onwards is in reality a native latrine as already stated, and on this account the sand on the beach cannot be considered as safe for cleansing purposes. It may be well to mention that disease epidemics in camps at home have been traced to the sand employed for cleansing mess-tins.

(*i*) *Native Cooks and Waiters should be avoided.*—The reason for this is obvious, as many natives must be carriers of amœbic cysts and typhoid bacilli and no one can guarantee the cleanliness

of their habits. This measure is also of importance with regard to malarial fever, since malarial carriers infective to mosquitoes are commonly natives.

(*j*) *Uncooked Vegetables* used in making salads should be avoided as a food unless they are first carefully washed and then dipped for a few moments into boiling water. Vegetables not treated in this way must be considered dangerous, as in the East the vegetable gardens an frequently manured with human fæces.

(*k*) *Warnings to Soldiers.*—Soldiers should be warned to avoid partaking cf uncooked food in filthy native localities. Ices, milk and salads are especially liable to be contaminated.

(*l*) *Recommendations with regard to Hospitals.*—Cases of amœbic and bacillary dysentery should be regarded as infectious as cases of typhoid fever. They should therefore be isolated as much as possible. The hands of nurses and orderlies in attendance should be washed in antiseptic lotion before leaving the cases to attend to others, and before partaking of food, etc. Fouled clothing and bed-clothing should be dipped immediately into antiseptic lotion, so as to prevent flies from alighting on them. The hands must be washed after handling such clothing, and also after the handling of bed-pans. When bed-pans are sent to the laboratory so that the fæces may be examined microscopically, the report paper should not be secured between the bed-pan and its lid, as is almost invariably done; because in this way the report sheet is frequently soiled with highly dangerous fæcal material. Orderlies should be thoroughly instructed in these matters, and thereafter punished if these instructions are not carried out. Flies should be constantly destroyed in all hospitals by the use of fly-papers, fly hand-nets and every other means. The wards, especially those containing cases of dysentery and typhoid fever, should be screened. This would entirely obviate the use of mosquito netting over the beds. Screening when done must be done thoroughly, since an imperfectly screened room or building only acts as a gigantic fly or mosquito trap. The mess-rooms and kitchens of hospitals must also be rendered fly-proof, and all food must be covered with gauze to prevent flies from alighting upon it.

(*m*) *Thorough Emetine Treatment to prevent the Production of Dangerous Cyst Carriers.*—We wish to repeat once again that this is an important sanitary measure. All evidence goes to prove that never less than eight grains should be given in cases of amœbic dysentery in one continuous treatment. If all early cases were treated in this way the majority would be cured at once and few

chronic cyst carriers would be produced. The habit of giving only one to four grains is dangerous, as already stated, and must be abandoned. Cyst carriers may require a long-continued treatment of twelve grains and over combined with saline.

(*n*) *A Larger Sanitary Staff is necessary in badly sanitated Warm Climates.*—We beg to recommend a larger sanitary staff and equipment per unit of fighting strength. Moreover, the sanitation alone should be directed by a special officer of sufficiently high command to insure that the necessary measures are quickly and thoroughly carried out. Additional staff and equipment mean, no doubt, greater encumbrance and expense to an army, but it would be repaid tenfold and more by increased efficiency and by the reduction of expenditure required to look after and transport the sick and diseased. Sick and diseased troops constitute always a much greater encumbrance to an army than an increase of sanitary squads and sanitary equipment.

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(X) Explanation of Plates.

All figures are drawn to the same scale from specimens prepared by wet fixation (Schaudinn's fluid) and stained with Weigert's iron-hæmatoxylin. Figs. 66, 67, and 68 were drawn to the same scale from fresh unstained specimens. Magnification, 750 diameters.

PLATE I.

FIGS. 1 to 5 represent the phases in the simple division of *Amœba limax*, from a culture of sand on agar.

FIGS. 6 to 9 show a different and more rare type of multiplication by schizogony, from the same culture.

FIG. 10.—Such a figure as commonly seen in culturé preparations may only represent amœbæ crawling around a partially encysted form.

FIGS. 11 and 12 show ovoid structures containing *limax* amœbæ. These may possibly represent splits in the agar into which the amœbæ have crawled.

FIG. 13.—*Amœba limax* cyst. Note crinkling of the cyst wall.

FIG. 14.—*Amœba limax* cyst with two nuclei. This is very rare.

FIGS. 15 to 20 show chromatin changes within the cysts of *Amœba limax*, and may possibly indicate sporogony. (From agar cultures.)

FIG. 21.—Spore-like bodies often found in sand cultures on agar.

FIG. 22.—Sporing body rarely found in agar sand cultures. This may or may not be a phase in the *Amœba limax*.

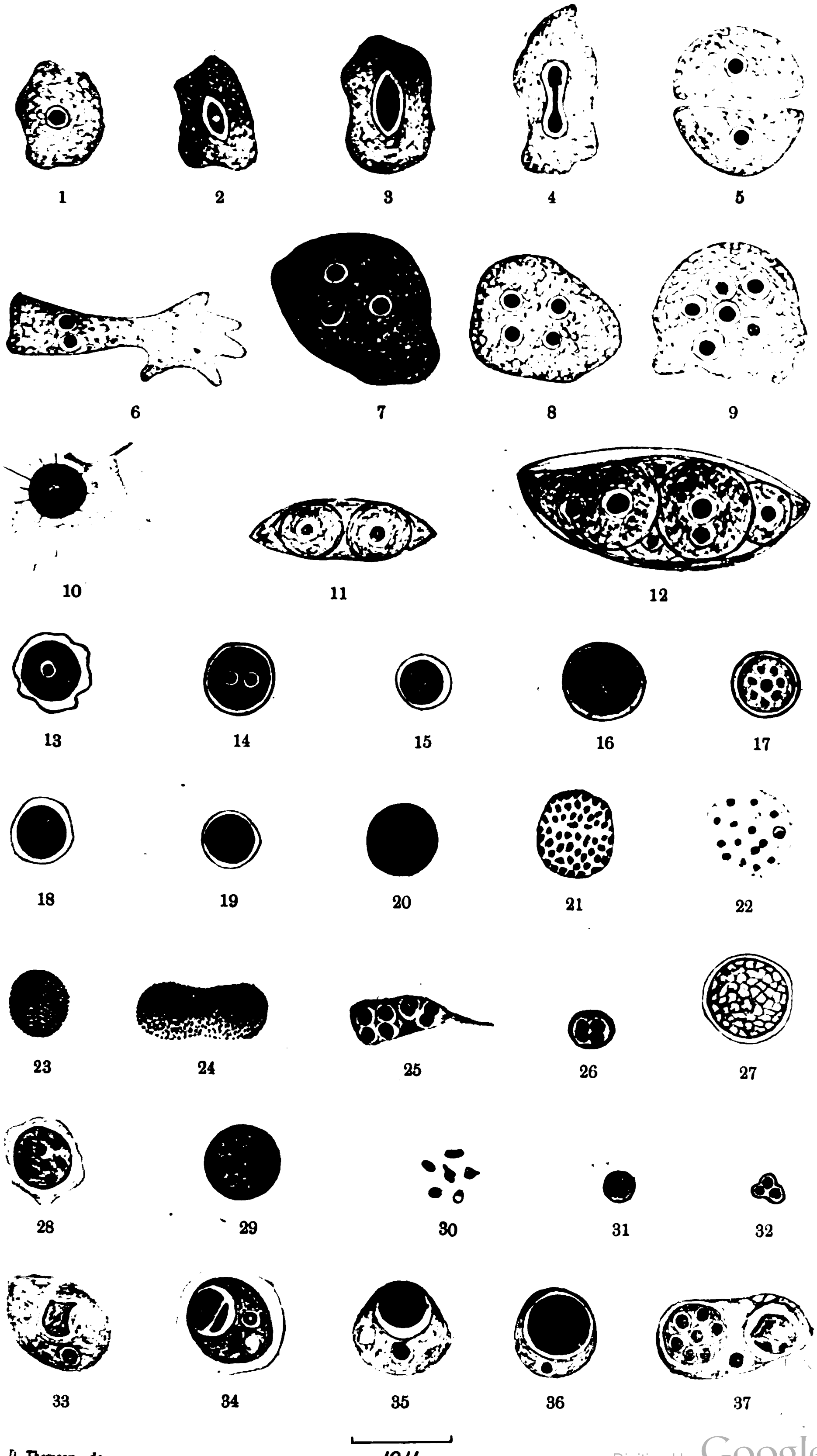
FIGS. 23 to 26.—These bodies were found in *Amœba limax* cultures from the sand. Their nature is unknown.

FIG. 27.—This represents a mould spore. (From an agar culture of sand.)

FIGS. 28 to 32 represent sporing bodies found in the sand aquarium, which may or may not be phases in the life-cycle of *Amœba limax*.

FIGS. 33 to 37.—Peculiar bodies (nature unknown) found in agar cultures from the sand.

PLATE I.



D. Thomson, del.

PLATE II.

FIGS. 38 to 40 represent spirochætes which are commonly found in human fæces and which also exist in sand-water mixtures kept in the dark.

FIGS. 41 and 42.—Spirochætes rarely found in the fæces and also found in the sand and water mixtures.

FIG. 43.—Green vegetable filament (*Ulothrix zonata*) found in the sand aquarium. Also found rarely in human fæces.

FIG. 44.—Green vegetable filament (name undetermined) found in the sand aquarium, and also rarely in fæces.

FIG. 45.—Diatom found rarely in the fæces but present in large numbers in the sand aquarium.

FIG. 46.—Sprouting mould spore found in the fæces and also in the sand aquarium.

FIG. 47.—Vegetable? (name undetermined) found in the sand and also very rarely in the fæces.

FIG. 48.—Protozoal organism (name undetermined) found frequently in the sand aquarium and also rarely in the fæces.

FIG. 49.—*Amœba limax* as found in sand and fæces.

FIG. 50.—Species of *Balantidium* or *Nyctotherus* (name undetermined). Frequently grows on sand-agar cultures, also cultivated from human fæces.

FIG. 51.—Cyst of the same showing two daughter cells.

FIG. 52.—Cyst of the same showing four daughter cells.

FIGS. 53 and 54.—A species of *Bodo* resembling *Heteromita rostrata*, cultivated from the sand and also from the fæces on ordinary nutrient agar.

FIG. 55.—Cyst of a *Bodo* or *Prowazekia* flagellate from an agar culture.

FIGS. 56 and 57.—Species of *Prowazekia* cultivated from the sand and also from the fæces.

PLATE II.

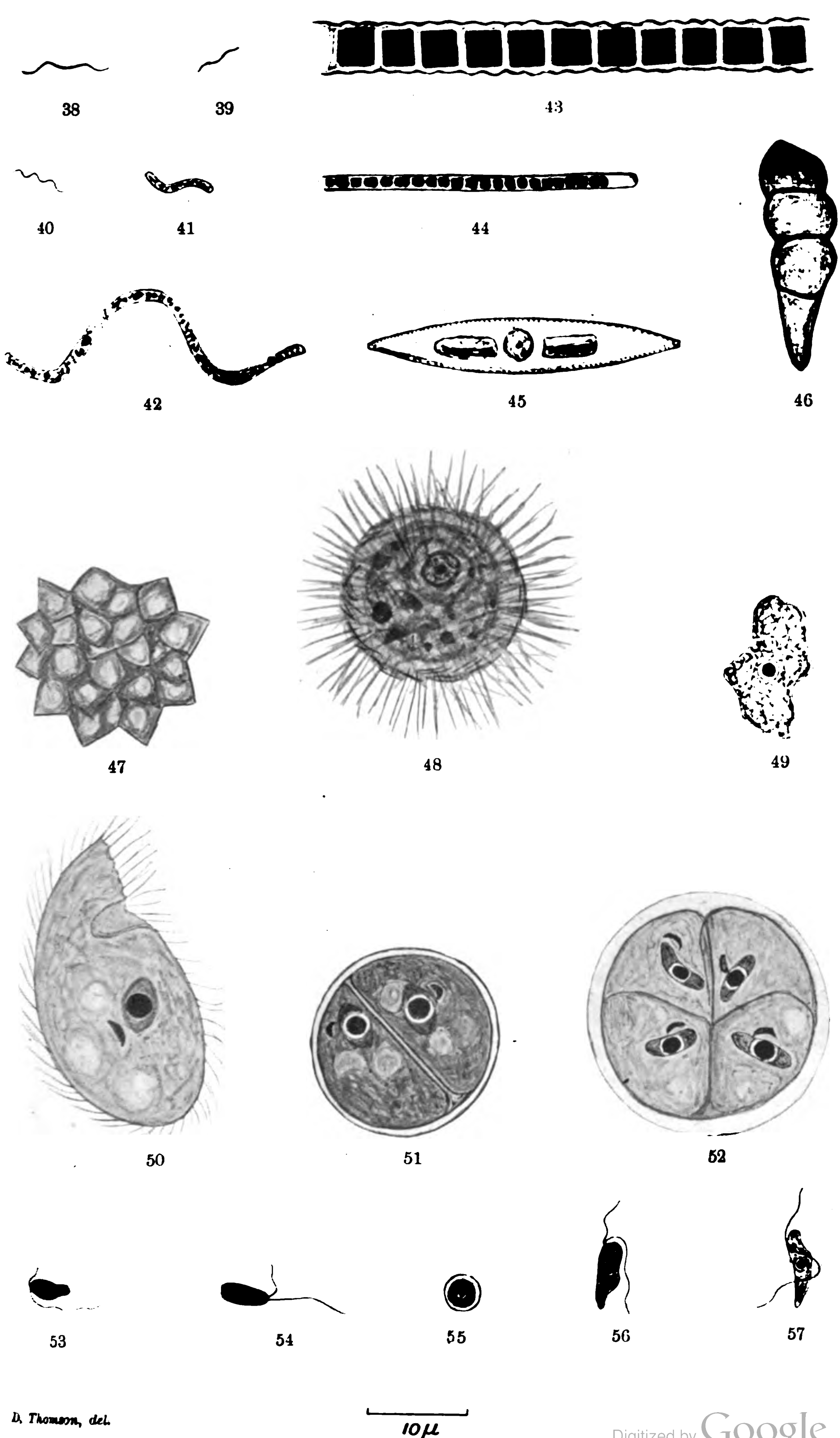


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PLATE III.

Fig. 58.—Wheel-like organism (*Striatella interrupta?*) from the sand aquarium.

Fig. 59.—Same organism undergoing division into two.

Fig. 60.—Same organism showing apparently many nuclei.

Figs. 61 to 65.—Types of amœbæ found in the sand aquarium.

Fig. 66.—A flagellate, *Astasia margaritafera?* (*Euglenaceæ*), found in the sand aquarium. Drawn from an unstained specimen.

Fig. 67.—Peculiar slug-like amœba (name undetermined) found rarely in the sand aquarium. Drawn from an unstained specimen.

Fig. 68.—A green organism, *Scenedesmus caudatus* (*Scenedesmaceæ*), rarely found in the sand aquarium. Drawn from an unstained specimen.

Fig. 69.—Green organism, *Pandorina morina* (*Volvocaceæ*), found in great numbers in the sand aqnarium.

Fig. 70.—Same organism in colony form.

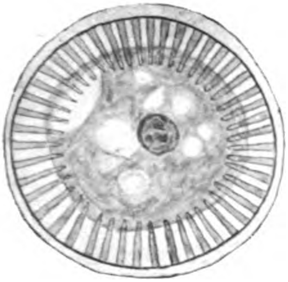
Fig. 71.—A green flagellate, *Euglena quartana* (*Euglenaceæ*), commonly found in the sand aquarium.

Fig. 72.—Organism (name undetermined) probably one of the *Rhynchoflagellata*, rarely found in the sand aquarium.

Fig. 73.—A biflagellate (name undetermined) commonly found in the sand aquarium.

Figs. 74 and 75.—A four-flagellated organism (name undetermined) commonly found in bouillon cultures of the sand.

PLATE III.



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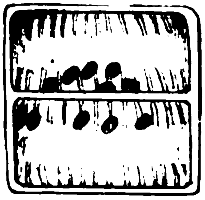

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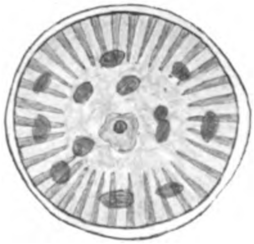

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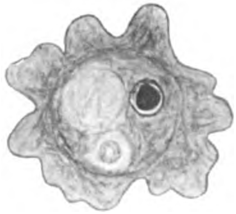

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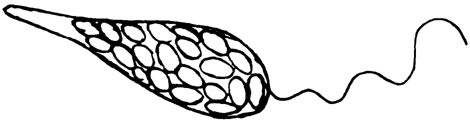

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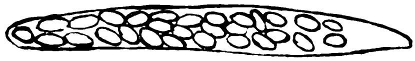

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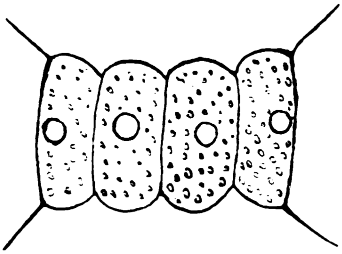

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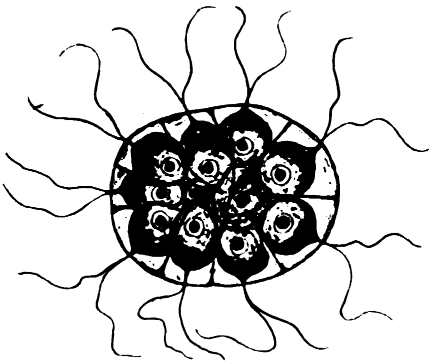

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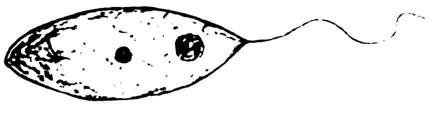

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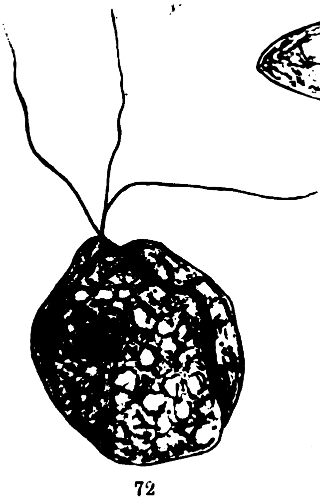

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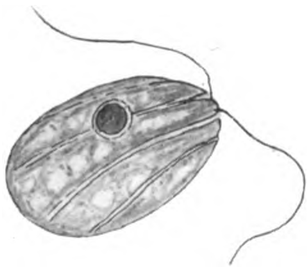

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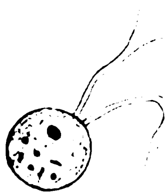

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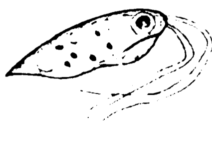

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D. Thomson, del.

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PLATE IV.

FIG. 76.—Organism (name undetermined) rarely found in the sand aquarium.

FIG. 77.—Organism (nature unknown) rarely found in the sand aquarium.

FIG. 78.—Flagellate (name undetermined) commonly found in the sand aquarium.

FIG. 79.—A ciliate organism (name undetermined) frequently found in sand aquarium. It always contains a triple nucleus.

FIG. 80.—*Euplotes harpa* (*Ciliata*), found in the sand aquarium, and sometimes also appears on agar cultures of the sand.

FIGS. 81 and 82.—A ciliate somewhat resembling *Maupasia paradoxa*, frequently found in the sand aquarium.

FIG. 83.—A ciliate (name undetermined) commonly found in the sand aquarium.

FIGS. 84 and 85.—Spore-like bodies (nature unknown) found in agar cultures from the sand.

FIGS. 86 and 87.—Spore-like bodies (*Sporozoa ?*) found rarely in the sand aquarium.

FIG. 88.—*Oocystis solitana ?* (*Scenedesmaceæ ?*) found in the sand aquarium.

FIG. 89.—Spherical mass of spores (*Sphaerita Dangeard ?*) found frequently in the sand aquarium. These masses of spores vary much in size.

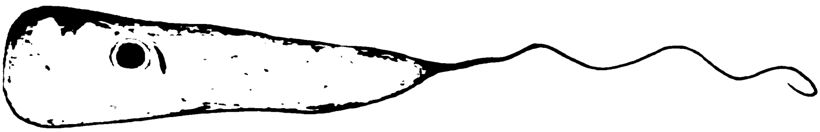
FIG. 90.—Organism (nature unknown) from sand aquarium.

FIG. 91.—*Oocystis pelagica ?* (*Scenedesmaceæ ?*) from sand aquarium.

FIGS. 92 and 93.—Organisms (nature unknown) from the sand aquarium.

FIGS. 94 and 95.—A species of minute flagellate ? (name undetermined) found in large numbers in sand and water mixtures, especially when some glucose is added.

PLATE IV.



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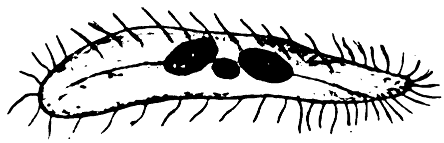

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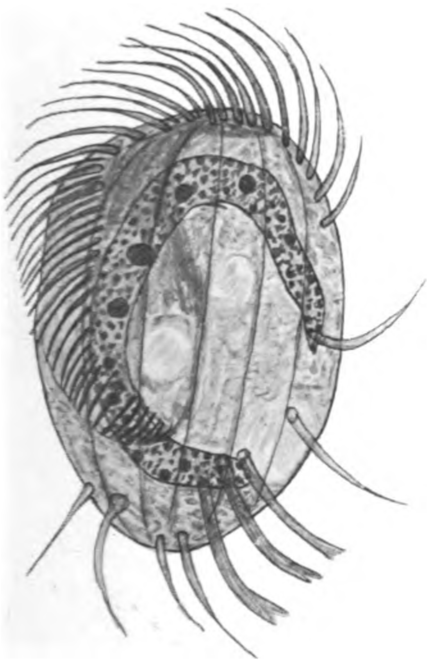

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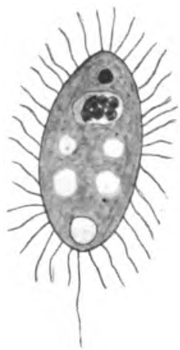

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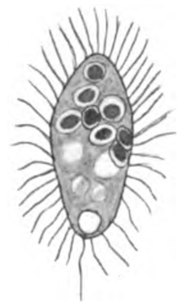

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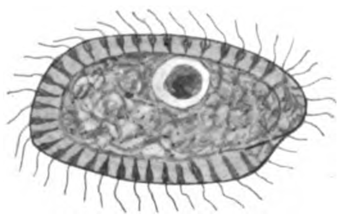

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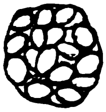

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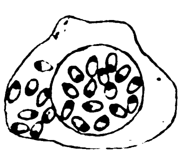

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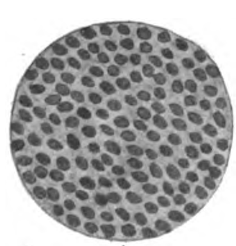

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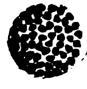

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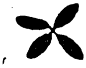

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D. Thomson, del.

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THE LOUSE PROBLEM AT THE WESTERN FRONT.

By Lance-Serjeant A. D. PEACOCK, M.Sc.(Dunelm).

Royal Army Medical Corps (Territorial Force).

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The insect dealt with in this paper is the clothes- or body-louse, *Pediculus humanus*, Linnaeus; Order, *Anoplura* or *Siphunculata*. The writer proposes to record observations on its natural history, its bionomics in relation to troops on active service, as well as suggest measures for its prevention and destruction.

ENTOMOLOGICAL.

Morphology.

Technique.—Microscopical preparations were made as follows: The insects were chloroformed, fixed in formalin (10 per cent) for a day, brought through the alcohols (50 per cent, 70 per cent, 90 per cent absolute), cleared in xylol for a day or two, and mounted in Canada balsam. The drawings have been carefully drawn, and are as detailed and accurate as opportunity has permitted; but further work will, no doubt, reveal other features which may necessitate slight additions and modifications to them. The musculature and mouth-parts, for instance, are not fully worked out. The nomenclature of the parts may possibly need correction. As the writer is not aware of any other detailed drawings of this insect, it is hoped that these will be of utility. For bench room and facilities to finish certain microscopical and recording work, the writer wishes to acknowledge the kindness of Captain MacNee, R.A.M.C.

External Characters.

Only the most significant features are dealt with. The female is the larger, being about four millimetres in length, while the male is about three millimetres. The proportion of the sexes is about equal. Soldiers speak of *black* and *grey* lice, and, with regard to the question whether these are different species, no distinctive features have been discovered which would necessitate separate classification. The black louse has a more dusky integument, the edges of the body are darkly pigmented, and the dorsal regions of the segments darkly patched. Murray gives the information that the different-coloured races of men have lice coloured

to match. On the question whether the black variety exists peculiarly at the Front or more abundantly in proportion than in England there is no evidence available. One thousand eight hundred lice counted yielded 5·4 per cent black. The bristles, of which there are two kinds, long and short, are placed all over the body, are somewhat sparse in number, and roughly symmetrically arranged.

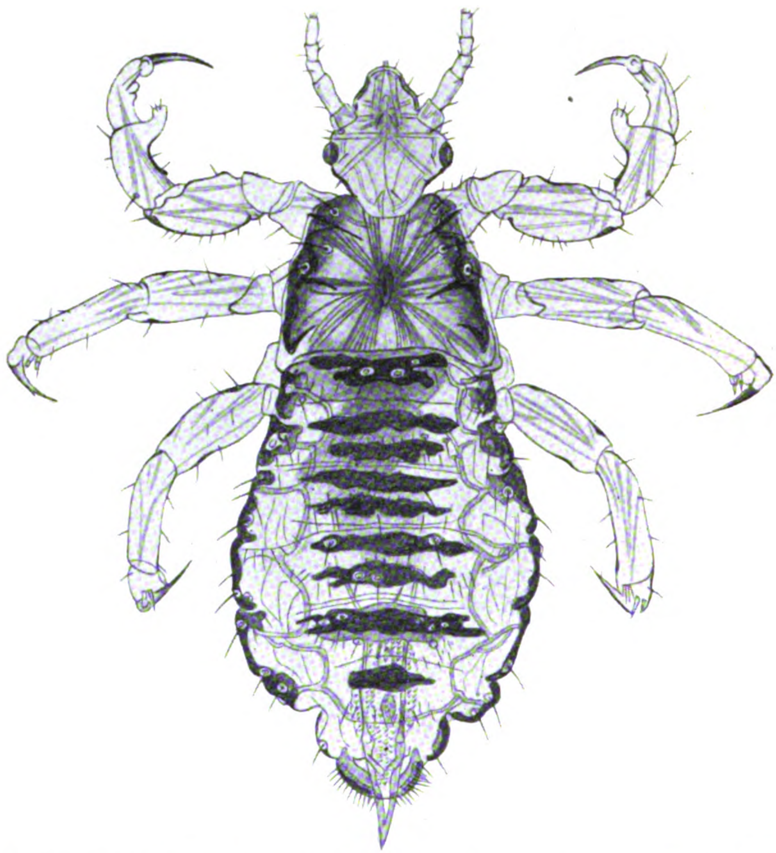

FIG. 1.—The clothes-louse (*Pediculus humanus*, Linnaeus [synonym, *P. vestimenti*]. Male: black variety; enlarged about sixty times. Drawing made from cleared specimen, viewed dorsally, and seen by transmitted light.

Head (*see* diagrams).—This bears the very simple sensory organs, the antennæ and the black eyes. The entrance to the alimentary canal is at the anterior end of the tubular chitinous mouth-part (5), which is nearly surrounded by a projecting sheath (1).

This sheath arises from a thin chitinous diaphragm which forms the greater portion of the anterior part of the head. The dorsal margin overhangs and forms a blunt rostrum (2). Ventrally are a pair of chitinous structures of unknown significance.

Thorax.—The three thoracic segments are fused and their boundaries are not sharply marked off. Mid-dorsally is an invagination. There are three pairs of strong legs which each end in sharp powerful grapnels and spines.

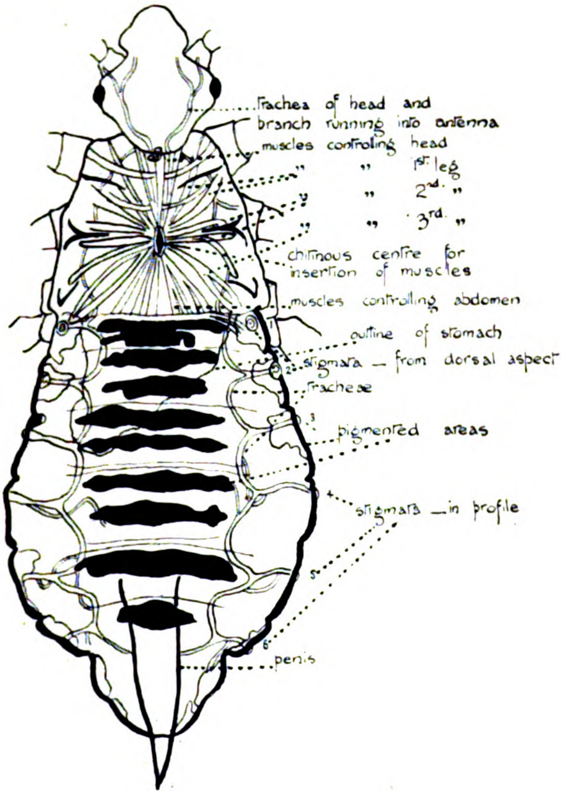

Fig. 2 (key to fig. 1).

Abdomen.—There are eight segments, the two posterior being fused. Each of the first six bears a breathing-hole, the stigma, on either side. The male is pointed at the posterior, and the sharp tip of the penis may often be seen extruded. The female's posterior is bi-lobed, and ventrally shows a pair of tooth-like appendages, the gonopods, which assist in copulation. In both sexes the anal region is fringed with numerous bristles.

Internal Characters.

Mouth-parts.—The interesting question of the homologies of the mouth-parts the writer desires to leave till a more appropriate season, and in the absence of knowledge on this point it would

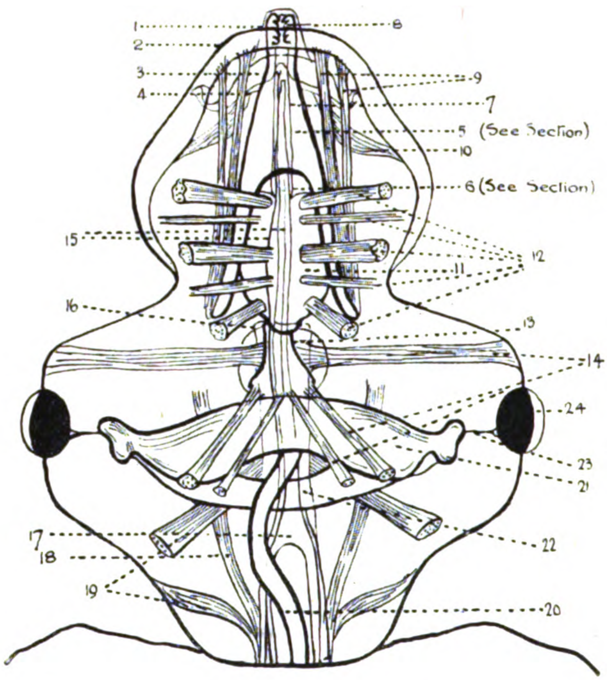

FIG. 3.—Diagram showing anatomy of head; dorsal aspect. Drawn from sections and cleared specimens; sections cut by Lieutenant J. Shaw Dunn, R.A.M.C. (1) protective sheath—incomplete tube; (2) projecting anterior dorsal margin of head; (3) paired anterior ventral structures; (4) anterior ventral margin of head; (5) chitinous outer mouth-part, with (6) its tube running forward (7) and terminal teeth (8); (9) protractor muscles of outer mouth-part, and (10) retractor muscles (?); (11) first pharynx, and (12) muscles; (13) second pharynx, and (14) muscles; (15) the two structures of the inner mouth-parts, the dorsal being thin and broad, the ventral narrower and thicker, with three (?) terminal points; (16) ventral sac lodging the inner mouth-parts; (17) bifurcated posterior ends of inner mouth-parts; (18) protractor muscles (?) of sac; (19) retractor muscles (?) of sac; (20) œsophagus—dorsal; (21) supra-œsophageal brain, and (22) sub-œsophageal portion; (23) optic nerve; (24) eye.

be best to use non-technical terms. The chitinous mouth-parts are—(1) an outer structure adapted for sucking and for supporting the first pharynx; (2) two inner structures adapted for stabbing.

The strong outer apparatus is tubular for a certain length at the mouth end. When the insect is not feeding the entrance

is lined with sharp chitinous teeth, seated in tissue and pointing inwards. When feeding, the outer structure is thrust forward a little, so that the mouth region projects beyond the protective sheath. This action, in some way, appears to relax the tissue bearing the teeth, and these, instead of lining the mouth, come to fringe it and point outwards. The first half of the outer structure dorsally is an arch which forms the roof of the beginning of the gullet. Backwards from the arch run two limbs, to which are attached the protractor muscles which out-thrust the structure. They also support the sides of the first pharynx. In the arch run two curved walls, which appear to have their origin just ventral to where the arch bifurcates and in the floor of the pharynx. Within these two curved walls lie the anterior portions of the two stabbing organs.

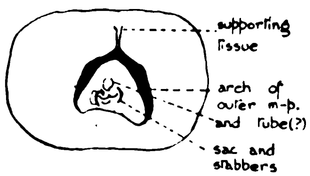

FIG. 4.—Transverse section through head at region 5 of fig. 3.

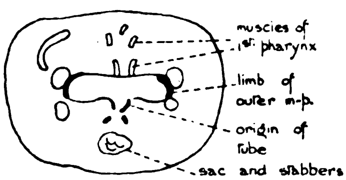

FIG. 5.—Transverse section through head at region 6 of fig. 3.

The inner mouth-parts, the two stabbing organs, are lodged in a tubular sac lying below the œsophagus, and extending from the back of the head to the first pharynx. They are similar in so far as both are flexible, long—nearly the length of the head—enter the first pharynx together, and bifurcate posteriorly. They vary in detail. The uppermost resembles a thin, broad chisel, double-grooved along part (?) of its length. The lower is like a gouge bit, the tip being three-pointed. Protractor and retractor muscles bring the apparatus in and out of action.

Alimentary Canal.—The writer does not fully understand the relationships of the various structures composing the canal anterior

to the first pharynx. It would seem, however, when human blood is being in-sucked, that a gutter or tube is formed, having for sides the curved structures of the outer mouth-parts, and, for a floor, the posterior length of the broad stabbing organ. It is possible, too, that the under stabbing organ becomes closely apposed to the upper, so forming a narrow tube leading to the wound.

Following this tube is the first pharynx, which has muscular walls and is lined with chitin. Its function as a pump is secured by the action of five pairs of muscles which diverge from it dorsally. The second and smaller pharynx resembles the first. It leads to a narrow gullet which opens into the stomach.

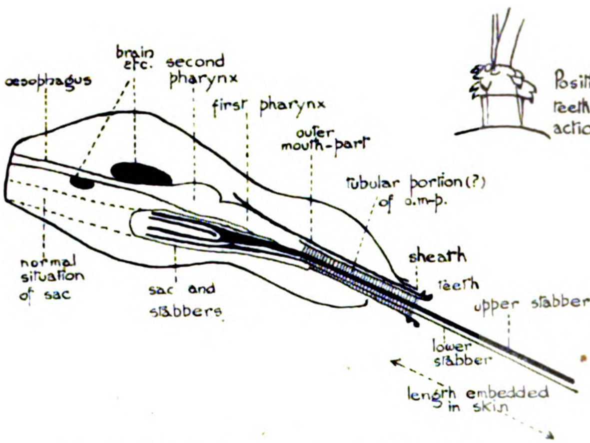

Fig. 6.—Diagram to illustrate mouth-parts in action.

For information concerning the salivary glands the writer is indebted to Major Sydney Rowland, R.A.M.C. The glands are situated far back in the thorax, and consist of two on each side, one bifurcated and one globular. The duct from the bifurcated gland joins with that of the accessory gland to form a single duct, and this opens into the sac of the stabbing organs.

The stomach is of very large capacity. Anteriorly it has two pockets. A short, narrow, single-looped intestine follows and leads to a slight swelling, the beginning of the rectum. Into the intestine open eight excretory Malpighian tubules. A short rectum ends at the anus.

Circulatory System.—This is probably typical, a long tubular heart lying in a pericardial space dorsal to the gut, with few vessels and large blood sinuses.

Respiratory System.—The lateral stigmata lead to the tracheæ, which branch to smaller vessels to ramify in the tissues.

Nervous System.—The brain lies behind the second pharynx, above the gullet, and is connected by lateral commissures to a sub-

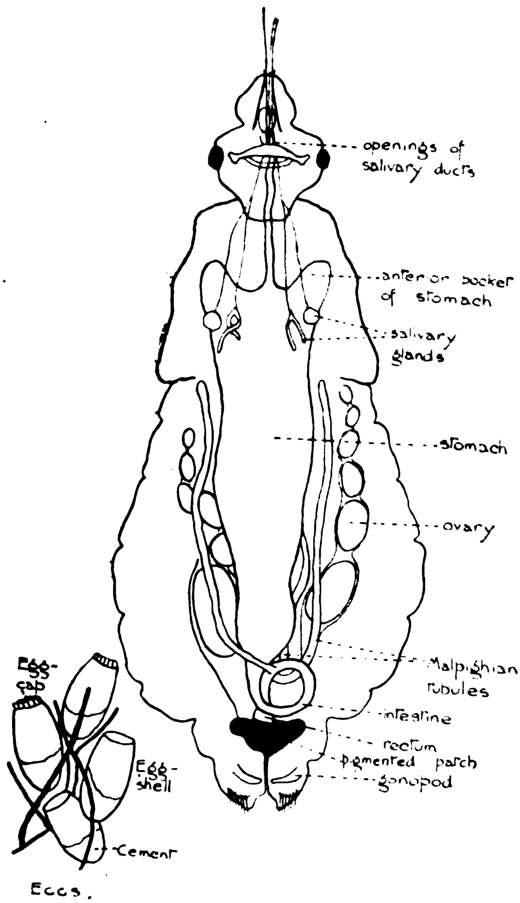

Fig. 7.—Diagram showing internal anatomy of female ; ventral aspect. Drawn from dissections and cleared specimens.

œsophageal portion. Backward from the subœsophageal ganglia runs the ventral nerve cord. An optic nerve runs from the brain to the eye. The antennæ are sensory. Apart from these there is a marked absence of any structures denoting special sense.

Reproductive System.—With the exception of the penis the

reproductive organs of the male have not been noted. Of the female only the eight (?) ovaries have been noticed. They are long tubes containing ova at various stages of development.

Insects, etc., resembling Lice.

Many insects, etc., found in dug-outs at first and casual glance may be easily mistaken for lice. The *wood-louse* or *slater*, a crustacean related to the crabs and lobsters, is regarded as an ancestral or originative type of louse.

Springtails, primitive insects which move by leaping, resemble lice when at rest. Certain small beetles may be taken for adult lice, and small mites, relatives of the spiders, look like young lice. These mites are very common in food which has been trodden into empty sand-bags and the floors of dug-outs.

HABITS.

Habitat.—For shelter the louse depends upon the clothing, particularly the garments worn next the body, and prefers the comfort of the seams. Soldiers express a habit of the insect graphically when they say " it digs itself in," and for this purpose the beautiful musculature and the strong claws and spines of the legs are admirably adapted. The shirt is preferred, but in many cases most eggs are found at the fork of the trousers. This is because the trousers are worn consecutively for a much longer period than the shirt. In order of importance the areas most favoured for egg-laying are the fork of the trousers and the armpits, and the triangles at the tail of the shirt. Next are the trousers, the shirt seams and then the neck, but under present conditions there is general distribution also. Eggs have even been found in the beads of rosaries. It will be noticed that the insect accumulates where there is plenty of warmth, plenty of humidity and plenty of shelter.

The possibilities of infestation are instanced in a case examined at a hospital. Apart from extreme lousiness of underclothing, the man actually had lice and eggs at the back of the neck of the tunic, the pocket seams inside the tunic, and the flap seams of the pockets. A walking distributing agent!

Alimentation.—The insect feeds by sucking human blood, and adult lice may suck for twenty minutes at one time. They feed voraciously and wastefully, their excreta often consisting of what appears to be undigested human blood. The peristalsis is violent,

and the whole alimentary canal may move backwards and forwards while feeding is in progress. Young lice feed immediately on hatching. In consonance with Warburton's experiments, it was found that the young may be reared by feeding twice a day on the arm. They suck for any length of time between nine and twenty-two minutes, averaging twelve. If allowed to feed three times a day they do not suck so long at one time.

The process seems to be: The stabbing organs are out-thrust, pierce deeply and the sucking tube is anchored by the circum-oral teeth to the skin; by means of muscular action on each pharynx the blood is drawn in; leakage into the sac of the stabbing organs is prevented by the upper stabber; the saliva pours into the sac, and possibly via a tube formed by the upper and lower stabbers reaches the wound and prevents the coagulation of blood; the blood is digested in the stomach and intestine; the waste products from the gut and Malpighian tubules pass through the rectum and anus.

Life-history.—Concerning this it has not been possible to conduct many experiments.

In copulation the male lies below the female. The penis is extruded, up-curled and is retained in position by the gonopods of the female. The eggs are about 0·8 millimetre long and 0·3 millimetre in diameter, and, according to Warburton, one female lays five at one sitting and may produce a total of 125. They are clear and glistening when new, but towards the time of hatching appear a yellowish brown, due to the colour of the developing insect inside. The experimental method of incubation was as follows: Small pieces of shirt-seam bearing undisturbed eggs were placed in calico bags. These were tightly fastened with string to prevent the escape of any newly hatched young. The bags were slung next the body under the armpits and examined twice a day, morning and evening. The conditions, therefore, were almost natural.

One exact result of importance: A fortunate chance gave six newly laid eggs. One young hatched out in six days, three in about seven days, one in seven days and a half, and one in eight days.

A total of 291 eggs, of unknown age, taken in situ on eight pieces of shirt which had been discarded for about one day, yielded after two days' incubation the following:—

(1) A constant succession of hatchings each day of 9, 28, 33, 24, 10, 11, 20, 7, 72, 5.

(2) Total percentage hatched, eighty-two per cent.

(3) The greatest number took at least ten days to hatch. (Perhaps the one day's separation of the shirt from the body inhibited development.)

(4) Incubation may often take at least twelve days.

The attempts to rear the young in calico bags carried at the armpits and by freeing to feed twice a day were not very successful. The results differ, in certain respects, from those of Warburton. The first moult took place at various periods—e.g., about two days in one case, after three days in one case, five days in one case, and seven days in one case. One specimen lived fifteen days and moulted twice, the first time on the fifth day and the second time on the seventh. It looked only half-grown at the end of the time which Warburton suggests to be the limit of growth. The conditions of the experiments were almost natural, and the heavy mortality of the young is rather baffling and disappointing. It may be that the young are especially susceptible to even the slightest confinement.

Vitality.—The duration of life on the body is not known. Warburton kept a mature female alive for thirty days. This would make the total length of life about seven to eight weeks. The duration is said to be dependent upon three factors: abundance of food, the normal body temperature, and body emanations. Kept at 37° C. dry heat in a bacteriological incubator, lice die in about three days. Specimens were fed twice a day and kept on a piece of clean shirt in a cardboard cylinder. This was carried under the armpit, so ensuring body temperature without body moisture. The insects died in about five days. Body moisture, therefore, seems necessary to the insects, but what is the more essential, the humidity only or the chemical quality, is not known to the writer. To these factors it is proposed to add freedom. Even under the very slight restraints imposed during experiments, the adult insects died quickly, that is, in two or three days. *As a result of many experiments it was found that the longest period during which lice survived separation from the human body was nearly nine days.*

The following results were noted :—

On an infested shirt, newly discarded and exposed to the open, during which the temperature varied between 40° F. and 45° F., two days being raw and wet, lice lived as long as five days.

On infested shirts, taken singly and stored in large Army biscuit tins or in brown paper parcels, they may live about seven days; on shirts stored in bulk, eight days.

Placed upon freshly won soil, they live seven days. On a piece

of shirt which was placed upon soil in a large biscuit tin they lived eight days. Dry soil to the depth of two inches was placed on the bottom of a box 2 feet by 1½ feet by 1¼ feet, and covering the soil were laid pieces of wood, so imitating in miniature the conditions of a dug-out. A lousy shirt was placed in the box. The lice congregated upon the uppermost part of the shirt and remained there alive for eight days.

A constant feature is the moribund condition into which the insects sink after two days' separation from the body. This condition lasts till death. On taking a moribund louse and placing it on the arm, there is evinced a quick response. The insect begins to take a distinct interest in life and shows it by perambulation and feeding. In connexion with this "warmth test" it is important to note that it may need to last quite five minutes at times.

With regard to vitality when subjected to various insecticides, these results were noted (*see* Section "Methods of Prevention and Destruction"):—

Infested shirts dusted with a white mercury powder, advertised as a vermicide, still held live lice at the end of four days. A similar test, using a powder of heavy oil residue (sulphonated), talc and aloes, gave the result that the lice lived nearly nine days. The insects crawled regardlessly through both powders. Placed upon a small piece of shirt in a pill-box, the bottom of which was smeared with vermijelli, they died in two hours, not having sense enough to keep away from the insecticide. They were killed by suffocation, their bodies becoming sticky with the preparation and the stigmata choked. Similarly placed above N.C.I. powder, they died in half an hour. A single infested shirt dusted with N.C.I. did not hold a live louse in ten hours. Shirts, each dusted with N.C.I. and stored in bundles of ten, each bundle being dusted above and below, did not contain live lice after three days. An infested shirt was immersed for half an hour in an emulsion of soapy water and crude paraffin oil (0·75 per cent of emulsion being oil). The lice revived and lived in pill-boxes for seven days.

The maximum time during which eggs away from the body may remain dormant has been found by Warburton to be about forty days. This was under laboratory conditions in England, and the temperature fell at times below freezing point. Similar experiments were carried out here, shirts holding eggs being exposed to weather conditions. Samples taken from one shirt which had been exposed for eight days hatched after four or five days' incubation on the body. During the time of exposure the temperature fell

twice to freezing point, and two days were raw and wet. Samples taken from a shirt exposed thirteen days did not hatch after twenty-eight days' incubation.

In applying this knowledge the important fact is that eggs on the clothing, particularly the outer garments, if not treated regularly by ironing or disinfection, are a possible source of infestation for as long as a month after laying. Also, the removal of the clothing from the body for a few days in order to kill the eggs and lice by exposure is not a practicable scheme.

The existing scanty information on the parasite's powers of endurance indicates them to be small. The examples cited, however, show that these powers are by no means inconsiderable.

The louse, therefore, is a parasite which is utterly dependent upon man's blood for sustenance and man's body and clothing for prolonged prosperous longevity and reproduction.

Instincts.

Migration.—To discover the capabilites of the louse with regard to its powers of locomotion and distribution, the following simple experiments were made: On four occasions, for a period of at least one hour, the tracks of four lice were charted. The diagrams illustrate two typical results.

The distance between the two lice farthest apart was nine feet, two covering a distance, measured in a straight line, of five feet. The routes pursued were decidedly devious and exploratory. There was no desire evinced to make for a recently discarded shirt which was laid as bait six and twelve inches from the insects. These experiments demonstrate how, under certain conditions, the louse may go far afield to find a local habitation and a means of livelihood.

It has been observed that the insects may climb the wall of a room to a height of three feet.

A box was made into a miniature dug-out; twenty lice were placed in it and watched with very short breaks for eight hours. The insects scattered quickly, roamed round, and twelve in all left the box within half an hour. The remainder were lost. In another case, in which straw was placed in the box, only two migrated after two hours. After twenty-four hours two were found on the straw and six on the boards. The remaining ten were lost.

Such migratory powers are most probably only fully exerted in times of stress. This is borne out by their curious habits of "congregating." Whenever lice upon discarded clothing were the

subject of experiment, most of them invariably made for the uppermost portion of the material and showed no desire to forsake it. There is, therefore, a decided preference for warm material. On a shirt in a condition generally termed "walking" were computed ten thousand live lice. This would indicate gregarious habit and comfortable inertia, and that competition is no incentive to migration.

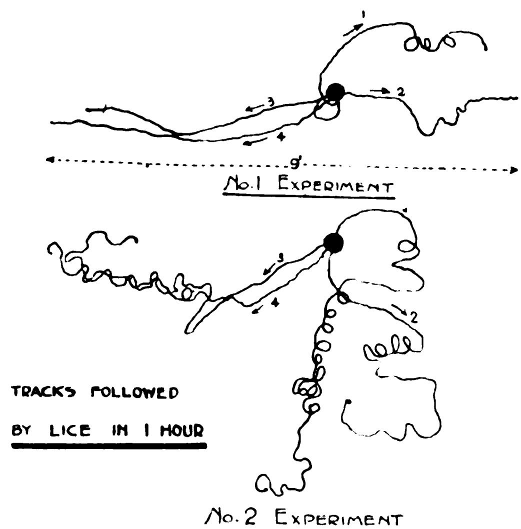

FIG. 8.—Tracks of lice. The breadth of the diagram represents nine feet.

Lice certainly do wander from the host. Although no experiments have been performed with the definite aim of ascertaining the stimulus of wandering, five months' experience with the insects suggests that if the surroundings of the host be warm and comfortable, lice are tempted to wander about. Such conditions exist in a warm bed, or when soldiers are packed closely together. The insect, though moving about, is in its native air all the time, and there is not the adventure of changing an environment. In such a manner a bed may be infested through the louse not being fortunate enough to return to the host before he leaves the bed, and also other men, clean or otherwise, may become infected.

Selection and Preference.—Lice soon find the body if the host sleeps on any infected bedding. The discovery of the host may be due to three causes: (1) The warming of the bed giving the incentive to wandering; (2) contact of the lice and the body; (3) the insect "scenting" the host. Which is the most important

factor is not known. A deliberate effort to reach the human body or recently discarded and sweat-impregnated clothing has never been observed. The instincts of detecting and pursuing the host seem, therefore, to be very feeble, if not absent.

These instincts being at best so feeble, it seems still more improbable that the parasite has any instinct of preference, i.e., as popularly expressed, "choosing one person rather than another." Three types suffer most from lice—the person badly infested, the person with a very sensitive skin, and the person who has never been verminous before. The first type may be an unfortunate soldier, physically unclean, through campaigner's luck, or maybe a man of unclean habits, in both cases the parasites having every opportunity for success. In the other two types it is a matter of susceptibility to the touch and stab of the insects.

Medical and Military Significance.

Scratching such as louse irritation induces renders the skin prone to sepsis. "Louse-rash," if it may be termed so, has been found distressingly common and has frequently been mistaken for scabies.

Lousiness is felt mostly at night. This is in spite of the fact that practically the same number of lice is present on the body during the day. Probably the distractions of the day keep the mind away from the pest, but at night, when everything is conducive to the desire for rest and comfort, the mind is most sensitive to the slightest irritation. Then the crawling of the insects, their sharp stabs, the itchiness of each tiny wound and the fierce desire to scratch become intolerable. As one man said: "You feel as if you could rive yourself to pieces." Sleep at best is broken and uneasy, but is usually impossible. Consequent upon loss of sleep, impaired vitality and mental weariness become very real miseries to the soldier, the value of whom depends upon a high pitch of bodily well-being. These are the soldier's most acute troubles primarily due to lice at this Front, but it must never be lost sight of that the menace of typhus, possibly more imminent at the Eastern Fronts, is still present at the Western.

"Lousiness."

It is rather important to obtain definite information as to the condition known as "lousiness" for the following reasons:—

(1) At the time of writing the writer is unaware of any exact statements on what really constitutes lousiness of the soldier; and

(2) The necessity, therefore, of establishing a standard by which to judge the condition of men or a unit.

(3) To ascertain what general improvement is manifest in a unit after the operation of methods of instruction and combating.

The method of estimating the verminous condition of men was as follows: The shirt was examined in areas—right arm, left arm, right body-seam, left body-seam and remainder of shirt. The numbers of lice on these areas were totalled. The areas taken on the trousers were—fork-seam, running from front to back of waist, right leg and left leg. Eggs were estimated—few (f), abundant (a), and very abundant (v.a.). Particulars were entered thus:—

Unit. Date. Case	When last bathed	When shirt last changed	Number of lice	Eggs	Trousers when new or last treated	Number of lice	Eggs	Total
A 9.10.15 No. 1	Fourteen days	Fourteen days	24	va	Six weeks	46	a	70

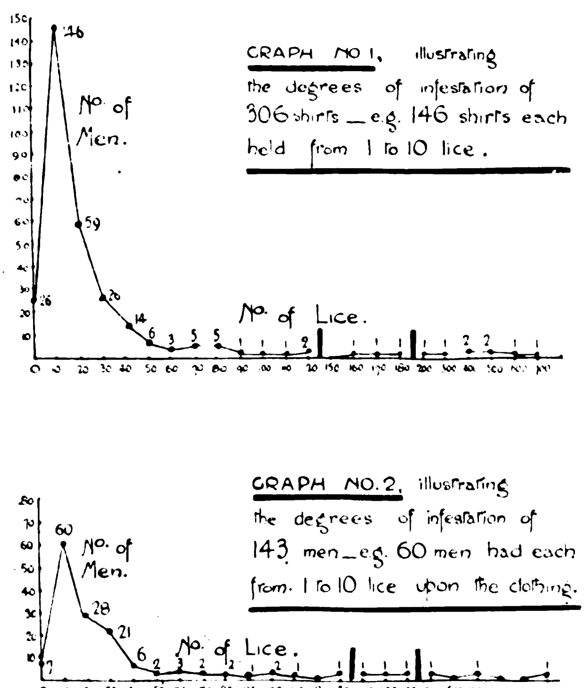

FIG. 9.—Graphs 1 and 2; number of lice.

As it was not always possible, especially at the commencement of the inquiry, to obtain full particulars of men fresh from the trenches, the condition of the shirts was examined on arrival at the divisional baths. The graph illustrates the result of this. Later, more opportunity was afforded for examination of the condition of men straight from the trenches, and the particulars were obtained at the baths and billets. The result is shown graphically.

From the graph is derived :—

Without any lice				.. ..	4·9 per cent.
With	1 and less than		10 lice	.. .. ..	41·9 ,,
,,	10	,, ,,	20 ,,	.. .. ..	19·6 ,,
,,	20	,, ,,	30 ,,	.. .. ..	14·7 ,,
,,	30	,, ,,	130 ,,	.. .. ..	11·2 ,,
,,	130	,, ,,	350 ,,	.. .. ..	4·9 ,,
,,	more than		350 ,,	.. .. ..	2·8 ,,

From the examinations it was found that the trousers (there were no linings in most cases) contained about two-fifths of the number of lice contained on the shirt. The number found on the socks is negligible. The average lousiness per man of a unit is approximated thus: from the average lousiness of the shirts, the average lousiness of the trousers was estimated, and the sum of these gave the estimated total lousiness. For example: average number of lice per shirt, 10·5; estimated average number per trousers, 4·2; estimated total, 14·7.

Average Lousiness of Units of a Division.

Particulars of all the units examined are not given in full, but the following table dealing with infantry is given for illustration :—

Unit	Number of men examined	Time since previous bath (mostly spent in trenches)	Average lousiness	Remarks
A	19	7 days	10·5	—
B	8	16 ,,	11·9	—
C	17	10 to 14 ,,	14·4	—
D	29	21 to 28 ,,	15·2	—
E	10	18 ,,	16·4	Shirts renewed eleven days before leaving trenches.
F	50	14 ,,	18·2	—
G	45	18 ,,	19·1	Shirts renewed ten days before leaving trenches.
H	33	14 to 21 ,,	22·7	—
K	51	28 ,,	27·8	—
L	12	14 ,,	31·4	—
Total ..	274	—	19·9 (variation 10·5 to 31·4).	

These general remarks may be made :—

(1) Experimental error is not due to the fewness of examples, because most of the units, where most men were examined, show the highest degree of lousiness.

(2) *Ninety-five per cent of the men examined were infested.*

(3) The condition of 274 infantryman of the division shows, in round figures, a lousiness of *twenty lice per man*, the variation being between ten and thirty. The division had then seen six months of hard work at different parts of the line.

(4) Cases of lousiness above 100 have not been included.

(5) Where clean shirts have been issued in the trenches, even for the short space of two days, the shirt at the end of that time attained the usual degree of lousiness. Young lice hatching from eggs on the trousers and also adult lice both evidently migrate to the shirt.

(6) Clean underclothing, after men have bathed, becomes re-infected from the outer garments within half an hour.

(7) Eighty-nine cases taken from infantrymen newly out from England since a fortnight showed a lousiness of six.

(8) Infantry transport sections of the division examined—of which forty cases were taken—showed an average lousiness of ten, half that of the men in the line.

These men were in bivouac, and changed and bathed regularly once a week; but because of the leather, the riding breeches were never treated with steam to kill the eggs.

(9) The cyclists (thirty-three cases), living in billets, changed and bathed once a fortnight, showed an average of eleven.

(10) Twenty men of the Royal Field Artillery, living in billets, changed and bathed once a week, showed the very low average of 3·5.

(11) As a contrast to this last example, fifty-one cases of the Royal Field Artillery newly out from England since a fortnight, and not changed or bathed in that time, showed the higher average of 7·9.

(12) A most interesting case is that of certain railway engineers. These men lived together in a large room, changed and bathed every week, and had been at the Front for three months. Not a single louse was found upon them. It is suggested, by nature of the work among oil, that to this factor is partly attributed the freedom from the pest.

(13) By reference to graph 2 it will be seen that there is a break after 130. This produces the result that nearly five per cent of men are what may be termed "maximum cases." These

"horrible examples" showed the number of lice upon each man to be 168, 180, 190, 376, 400, 552, and 895. Another shirt held 1,355 lice and 4,260 eggs, while another showed 10,428 lice approximately, and 10,253 eggs approximately. Reference has been made already to another extreme case.

"*Lousing*" *in the Trenches.*

The object of this inquiry was to ascertain, from the observations of the men themselves, what were the results of their self-searching for the pest. A certain division had served at two parts of the line, and the men from eleven different units were interrogated. Their average spell in the trenches had been about twelve days. The inquiry shows: (1) the average daily catch of the soldier was eight at one sector and nine at another; (2) the catch varied between nine and sixty; (3) that, from some source or sources, the man in the trenches is liable to a persistent daily visitation which insists on daily attention. The bag, as a general rule, is mixed, young and adults being obtained. Without encroaching on the section "Dissemination," it may be remarked that the main source of the young lice is undoubtedly the eggs on the clothing of the man himself. This accounts, in part, for the daily persistency of infestation. The difficulties of self-searching are great and may be responsible for the overlooking of some of the large adults; but the constant recurrence seems to indicate that other sources, external, supply the large specimens.

It would be expected that soldiers living in the bare trench, where no dug-outs exist, would be more free from lice than soldiers living in dug-outs. The contrast is afforded in the example of the division under inquiry. At one time of the year the men were in bare trenches at one part of the line and six months after they occupied dug-outs at another part, Men, however, were lousy to practically the same degree at each point. At the first place it was impossible to change clothing, and at the second they lived in close contact in dug-outs.

Lice and Dug-outs.—One of the most prevalent terms is "lousy dug-outs." Before conducting examinations in the first line of trenches, the impression obtained from conversation with soldiers—and others, too, of a more critical turn of mind—was that dug-outs were swarming with lice. The most comfortable form of dug-out is that which is completely boarded. More primitive types exist in which less wood is present and the floor is of earth. Five dug-outs of the boarded type were carefully searched. Included was

a large one occupied by six machine gunners. Skilful assistance in this search was given by a stretcher-bearer, an ex-schoolmaster. The search in each dug-out usually lasted an hour, and was conducted in daylight, with as much extra light as was possible to obtain from candles. In two cases the boards composing the floor were removed and carefully scrutinized, as were cracks and corners, with the fluff lurking there. Kits, great-coats and sandbags were subject to a like search. *In no case was a single live louse discovered.* Eight dug-outs with earth floors at another part of the line yielded a like result.

By reason of the military situation, a most interesting experiment was terminated before culmination. The stretcher-bearer and the writer took measures to secure freedom from the pest. They slept with less clothing than worn by men in the line, but using two blankets, for two successive nights, in a boarded dug-out newly vacated by three lousy soldiers. The conditions, therefore, were most favourable for picking up any lice present. After the first night an examination of the clothing and blankets gave a negative result. The night of that day the clothing and blankets were examined as carefully as candle-light permitted, and seemed clean, but the following morning the assistant's linings showed one louse and one flea. From one point of view, if this typical dug-out had been really a "lousy dug-out" it is reasonable to conclude that more lice would have been found on the clothing. It is quite possible, too, that the one louse found may have been obtained during the daily duties among the men, and overlooked at the night examination owing to the bad light.

It is not denied that lice may be present in dug-outs, but these play a minor part in the harbouring and disseminating of the parasite.

Lousiness of Material: Blankets.—In this connexion only two typical cases out of ten examinations are cited. The blankets of twenty-four infantrymen were searched. Their regiment had an average lousiness per man of 31·4 and had spent twelve days of the early autumn in the trenches. The blankets had been used for five days. Many were found free from lice. The highest number found on a single blanket was six alive, and the total number of lice found was only twenty alive, the average, therefore, being 0·8 per blanket. In the second example twenty-five blankets were examined in the winter, after being away from the men for about four days. Ten were free from lice; the highest number alive on a single blanket was two and the highest number dead was four.

The total numbers were five alive and twenty-one dead, the average, therefore, being about 1 dead or alive. The degree of infestation of the unit is not known, but is certainly no less than at any other time of the year.

In sporadic cases blankets have been found exceedingly verminous, holding twenty, sixty, and more lice. This condition was always correlated with the fact that the men using them were very unclean.

Blankets, therefore, are of minor importance as harbours and centres of dissemination.

Straw.—Straw sufficient for three men was placed in a corner of a room infested with 535 lice, and left for nearly four and a half days. At the end of this time three clean men slept for three successive nights upon it. After the first night the total number of lice from all the men was 18, the second night 4, and the third night 7. The experiment shows that infested straw may be sufficiently lousy at the end of seven days to infest men using it. A similar experiment, using 1,000 lice and leaving the straw five and a half days, showed 2 after one night's use, 2 after the second night's and 0 after the third night's.

Straw was placed as above, and infested with 500 lice. After three hours, to allow the insects to scatter and accommodate themselves, N.C.I. powder was dusted on the straw. After eight hours three clean men slept upon it. Next morning the total number of lice from all three men was seven alive and six dead. The straw was re-treated, and after the second night, with two men using it, no lice were picked up. The experiment demonstrates the efficiency of N.C.I. as a swift preventive of infestation from straw.

Palliasses.—Three palliasses, infested with 325, 500 and 500 lice respectively, were examined after eight days, and live lice were still found.

From the characteristic disinclination of the louse to leave clothing, it does not seem likely that straw will ever become very much infested.

Dissemination of the Pest.

Three sources of infestation may be conveniently named: (1) Living places—dug-outs, billets, bivouacs; (2) material—blankets, straw, beds; (3) the soldier, with his clothing and kit.

Living Places: Dug-outs.—Only the dug-out is discussed in this section, but the same remarks apply to billets and bivouacs.

The main problem presents itself thus. Men state confidently

that they go into the trenches clean, and in a few days find themselves infested. The general statement goes: "The dug-outs are lousy." It will be well to examine this critically.

If it may be assumed that a "lousy dug-out" was one which harboured twenty live lice, it is very unlikely that careful trained observation would not discover a single live specimen in thirteen dug-outs.

A man may have lice upon him all the time and not yet feel any discomfort. Such men, it has been found, always believe themselves to be clean, and generally declare it aggressively. Another unobtrusive but most important source of danger is the presence of eggs upon the clothing. There is the probability also of an unclean comrade.

The dug-outs with most uneviable reputation are those which are large and accommodate most men. Certain dug-outs—those of officers and senior N.C.O.'s—are frequently occupied by only one individual, and in these cases lousiness is not common. These living conditions, giving greater opportunities for change of clothing, for physical cleanliness, cleaner companionship, and often comparative isolation, are the converse of those of the men.

An important observation is the preference of the insect for remaining on warm material. This renders the probability of infestation from the soil very small, though, as has been pointed out, lice may endure surface soil conditions for seven days. In so doing, it is quite possible for infestation to come from the ground. The chance of this, however, is very remote.

When a dug-out has been emptied of all kit, sandbags, etc., such usually being the case when one unit makes way for its relief, most of the lice are removed also with that unit.

The weight of the evidence, therefore, goes to show that the dug-out itself is not an important factor in the harbouring and dissemination of the pest.

Material.—Previously mentioned facts show that in exceptional cases infested blankets may be centres of dissemination, but that, as a general rule, they are a minor source of dissemination.

From the preference of the louse for clothing worn next the skin, or such clothing discarded, and the absence of lice upon blankets and empty sand-bags used as bedding, it seems fair to deduce that straw and palliasses, which are colder habitats for the insect, will not be tempting places of sojourn for them.

The Infested Soldier.—Infestation from dug-outs and blankets being very slight, there remains the soldier himself. Concerning

the conditions of the soldier, it will be well to recall to mind that 95 per cent of soldiers who had seen six months' service were found lousy, that the average number of lice per man was 20, that 5 per cent (or 50 to a battalion of 1,000) were dangerous carriers, each bearing between 100 to 300 lice. Also to take the condition of a unit ready for the trenches after its few days' rest. During this time men are supposed to bathe and obtain a change of underclothing. Certain men have not bathed or changed owing to duty or through shirking, and most have not had the outer clothing ironed. That is, practically every man is still a carrier, while a certain few are likely to be in a worse condition.

Dissemination may possibly occur by three methods: accident, contact, and instinct on the part of the insect. In the first instance the ordinary actions of everyday life, dressing or undressing, may dislodge the insects from the inner clothing to the outer, or from the outer directly to the clothing of a comrade, or indirectly via blankets or kit. In the case of contact, transference may be effected during close proximity for a short time, as in the case of doctor and patient, teacher and scholar. More favourable and, to the mind of the writer, the principal conditions of transference are the long periods of proximity, engendering warmth and consequent movement of the lice, as when men are compelled to sleep closely together. The instincts of detecting and selecting the host seem at best too feeble to account for much dissemination.

The natural question is often asked, How did the parasite first gain a footing in the Army at the Front? In answer to this, the writer recalls the first day of mobilization, the pouring in of reservists to the barracks, among them many from the verminous slums; the mingling of mufti and khaki in the crowded rooms, and soon, with scant opportunity for obtaining anew the smartness and cleanliness of Army life, the hurried despatch to the seat of war. Once the louse was brought to the Expeditionary Force, the absence of facilities for washing and changing clothing, and the crowding together of troops, gave the parasite every condition favourable to lodging, feeding, multiplying, and spreading.

Methods of Prevention and Destruction.

Treatment of Cases Naturally Infested.—The condition of men was noted by the method already explained. The effects of various preparations were taken after one day, in most cases, and in a few cases for longer periods.

Treatment of Cases Artificially Infested.—Artificial infestation

was carried on by taking a known number of lice from a newly discarded shirt, and placing them on different parts of the body—i.e., down the legs of the trousers and inside the back and front of the shirt. After two to six hours, time sufficient for the insects to scatter, feed, and accommodate themselves to the new environment, the clothing and body were treated with preparations.

A large number of experiments with various insecticides was performed. The results, however, of the experiments were unsatisfactory from the point of view of obtaining consistent and comparative figures. More experiments, impossible at present, are required. It may be that such exact figures cannot be obtained by the very nature of the experiments. It is quite possible that the preparations act with greatly varying results upon different men. When opportunity is afforded, other experiments will be conducted upon more cases and for longer periods. Till the incorporation of such results, the figures available at present are withheld.

Insecticides act in two ways — (1) the effect upon the pest present, and (2) the deterrent effect on any of the insects present externally.

The insecticides used when the parasites were present produced either or both the following effects: they killed or caused to evacuate.

Resort is made to certain convenient terms.

Killing efficiency is measured by the percentage of insects killed in a certain time by the insecticide.

General efficiency is measured by the sum of the percentage of insects killed, evacuated and unaccounted for in a certain time.

Deterrent efficiency is measured by the percentage of insects which the insecticide deters from reaching the body.

It is still possible, however, to give the following notes on certain insecticides :—

N.C.I. (naphthalene 96 per cent, creosote 2 per cent, iodoform 2 per cent).—This preparation is a speedy killing agent, and is the best all-round insecticide tested. The investigator himself prefers it to any other preparation.

The following exacting test of its deterrent efficiency was made: Seven hundred lice were allowed to scatter in a sleeping bag improvised from a blanket. The writer used the preparation on the shirt, back and front, and on the riding breeches at the fork and as far down as the knees. The conditions were rendered as favourable as possible for the lice. Socks instead of puttees were worn, the shirt neck was opened, and the sleeves rolled up as far as

the elbows. Almost immediately after settling in the sleeping bag, lice were felt crawling in great numbers in the socks, on the arms, and a few at the neck—in fact, at those parts of the clothing and body not treated with the powder.

Next morning, examination of the clothing and body gave the following results:—

One hundred and fifty-five dead lice were shaken from the socks; thirty dead lice were found below the breeches' knees; one dead louse was found at the thigh. No lice were found on the shirt.

The point of importance is that the powder was a complete deterrent. The duration of the deterrent efficiency of N.C.I. is illustrated in the instance where thirty men of a machine-gun section of infantry were supplied with the powder. The men since using have not been troubled. Most are of the opinion that the effect of one thorough application lasts five days. A few dusted the clothing every few days as a preventive measure.

Caution.—It is most important to remember that a too free use of N.C.I., particularly at the fork, causes severe smarting. For this reason it is recommended that an ointment insecticide be used in this region. However, used with ordinary care, N.C.I. has undoubtedly proved the best insecticide for general use on the clothing material and in living places.

Vermijelli.—This ointment is very effective. It is found that the best way to use it is to anoint the body from neck to knees. Local application seems only to cause the lice to migrate to those parts of the body not treated.

Crude Oil Ointment.—The materials at hand permitted only a somewhat crude preparation. Two pounds of soft paraffin was melted, and four ounces of crude tar oil added. The mixture set like an ointment. Used like vermijelli, it showed a very much higher killing efficiency than that preparation, and a slightly higher general efficiency. As a deterrent it was subjected to the same test mentioned under N.C.I. and gave a result of 97·7 per cent efficiency.

N.C.I. and Vermijelli.—The ointment was smeared at the fork of the trousers and the seams, the N.C.I. being dusted down the shirt and trousers. The killing efficiency of N.C.I. was increased slightly, but the general efficiency was increased highly.

The report received from the medical officer of one infantry unit which used the preparation in the trenches is convincing. The preparations were efficient from three to seven days. After about

the third day it was found that young lice appeared, obviously from eggs on the clothing. Periodic treatment is therefore necessary. There was a great demand for more.

N.C.I. and Crude Ointment.—Used as above, the results were very similar.

Mercury Ointment (variously termed blue unction, blue ointment and navvy's butter).—To prevent undue absorption of mercury into the skin, equal quantities of the ointment and soft paraffin were mixed. The killing and general efficiencies were both high when the ointment was used like vermijelli. It is feared, however, that the nature of the preparation precludes that consistent use which present conditions demand.

To verify its effect as a deterrent, a similar test as in N.C.I., but employing only 300 lice, was carried on in accordance with a well-known treatment. Strands of tape, well smeared with the ointment, were fastened round the ankles, knees, waist, arms and neck. The precautions proved utterly useless. The lice simply swarmed over the body. After a somewhat unhappy two hours, and to secure rest, the body was smeared all over. Yet next morning thirty-five live lice were found on the body and clothing.

White Mercury Powder.—This preparation had very low killing and general efficiencies.

Sulphur.—Three experiments, one personal, were performed. In one case an ointment, half flowers of sulphur and half soft paraffin, and in two cases a generous amount of flowers of sulphur were used. They proved such complete failures that it is not proposed to pursue further experiments with these substances.

Treatment of Infested Underclothing.—The following notes are the result of many experiments carried on under the everyday working conditions at the divisional baths, treating clothing in quantity in large cauldrons, tubs and disinfectors.

Thresh Disinfectors.—For the horse-drawn "Thresh" it was found best that not more than 100 garments should be steamed at 215° F. for three-quarters of an hour. For the Foden lorry "Thresh" 100 garments per chamber should be steamed at 220° F. and five pounds pressure for half an hour.

Boiling Water.—When shirts have been *boiled* five minutes in water, lice are killed, and the eggs become white and opaque owing to the coagulation of the protoplasm. As a check, eggs at different parts of the shirts were incubated on the body for fourteen days. None hatched. Since writing the above it has been ascertained that Mr. Bacot, Entomologist to the Lister

Institute, working on a small scale with small numbers of eggs and test tubes, found that boiling for one and a half minutes was sufficient to kill the eggs.

Cresol solution, 1½ per cent, cold.—This solution is bactericidal strength. It was found after *thoroughly soaking* infested shirts for one hour that the lice were killed. Patches holding eggs were rinsed in cold water to get rid of the cresol and incubated on the body. After thirteen days no eggs hatched.

Chloride of lime, seven per cent, cold solution, used for twenty-four hours, is effective, but *alum, ten per cent, cold solution*, used for forty-eight hours, was a total failure.

The Rôle of Divisional Baths.—Apart from laundry work, the main object of the baths is to turn large numbers of infested men into clean men as quickly as possible. The three processes are the bathing, the issue of clean underclothing, and the disinfection of the outer garments. The first two are easily carried out, but the last presents many difficulties. Without it, the results of bathing and changing are of little value. Treatment by steam or gas disinfection takes too long, as it is usually necessary for men to pass through the baths in a quarter of an hour. Ironing with a hot iron is the most practicable scheme. This is a slow process, but one of cardinal importance, because it *determines the rate of bathing*. A bathing party being dealt with in a quarter of an hour, the time taken to iron the tunic, trousers, and cardigan jacket of each man being ten to twelve minutes, the number of ironers must equal the number of bathers per quarter hour. For example:—

Strength of Division	19,200
Rate of bathing	1 in fifteen days.
Number of men passed through per day	1,280
,, ,, ,, ,, per hour	160
,, ,, (eight hours' bathing per day) per quarter hour	40
,, of ironers required	40

Other considerations that may arise are—this bathing procedure, carried on regularly, will in time reduce the degree of infestation, so that less ironing will be necessary; as local conditions at certain times cause the baths to lie idle, it will be necessary to have other activities to hand, such as laundry or mending work, for the ironers.

Recommendations.

The main object of this section is to suggest an outline for a plan of campaign against the pest.

Research Centre.—The scope of this subject and virulence

of the pest make it necessary that a centre of research be established under a specialist in each army. The apparatus required is really very simple and small in amount. Assistants are necessary for laboratory and outside work. *Advisory work* could also be carried on as each unit is frequently a special case. Facilities for transport should also be afforded.

Instructional Work.—At these centres, instruction could be pursued by three methods :—

(1) *Classes* similar to those carried on for other military affairs could be initiated for such non-commissioned officers and men (Pioneers, Sanitary and Royal Army Medical Corps) as units may specially set apart for dealing with lice.

(2) *Lectures and demonstrations to military units* could be arranged, each unit being represented by officers, medical officers, non-commissioned officers, sanitary men, stretcher-bearers, and men in such numbers as may be convenient. A suitable time is when regiments are resting for a period longer than a week. The aims are the presentation of the true facts with regard to the pest, recommendations for dealing with it, and, most important, *to foster the idea that it is not by any means impossible to bring the parasite under.*

(3) *Issue of Leaflet.*—A short leaflet embodying the following could be printed and distributed to all ranks :—

"It is not correct to think that lousiness cannot be reduced to a minimum. Experiments, in detail and on a large scale, carried on among soldiers in billets and trenches go to prove—(1) that the soldier himself is the main source of infestation, (2) that the measures suggested below are of great benefit :—

(i) "Whenever possible, and as regularly as possible, search the clothing thoroughly for both lice and the 'nits,' or eggs. If you have discovered that the removal of the white patch which binds the seams at the fork of the trousers does not interfere with comfort, it is well to remove the patch. Special care during searching for the lice and eggs should be paid to this region.

(ii) "The great source of danger is the presence of eggs. These hatch in about a week. It is necessary, therefore, that the trousers should be ironed and brushed at least once a week. While in the trenches it is often quite possible, without undressing, to use a piece of hot metal or a tinder lighter. This removes the source of danger upon yourself.

(iii) "Against the lice themselves, whenever you find it necessary, use the remedies recommended. Powders, as a rule, should not be

used at the fork but down the shirt and trousers. Care should be taken to see that any powder which falls from the shirt to the fork should be small in amount, as too much is liable to cause smarting. If your stock of ointment and powder is exhausted, apply to the man in your unit who is responsible for the distribution of these preparations.

(iv) "Just previous to going to the trenches be careful to treat the clothing and body as directed.

(v) "Use the preparations about every four days. Experiments in the trenches have shown this to give the best results.

(vi) "See that any material, blankets, empty sandbags, etc., which may be present to increase the comfort of the dug-out or billet are treated with the powder preparation.

(vii) "*Take advantage of all the facilities offered at the baths.*"

Divisional Baths.

(1) Each Division should be provided with two baths, each capable of dealing with eighty bathers per hour, and two Foden lorry Thresh disinfectors.

(2) Baths should be built and not improvised (except in specially favourable circumstances) from permanent buildings. The design of the buildings should be such that contamination is impossible.

(3) *Procedure for Bathing.*—Man strips in undressing room, outer clothing handed in or collected for ironing; then enters bathroom and baths; enters dressing-room, given clean change of underclothing, uses insecticide, receives ironed clothing and dresses.

(4) *Treatment of Underclothing.*—Laundry work may possibly be carried on with advantage at one centre and not at each bath.

- (*A*) *Garments Disinfected in Thresh Apparatus.*—Three-quarters of an hour at 215° F. in horse-drawn type; half an hour at 220° F. and five pounds pressure in the Foden lorry type; washed, dried, folded, stored.
- (*B*) *Cresol Solution.—Auxiliary Method, suitable for Detached Units.*—Steep garments thoroughly for one hour or more in solution (one pint of cresol to eight gallons of cold water); rinse to rid of surplus cresol; wash, etc., in usual way.
- (*C*) *Boiling Water: Auxiliary Method for Detached Units.*—Allow garments to soak thoroughly and remain in boiling soapy water for five minutes; remove and wash, etc., in the usual way.

(5) *Treatment of Outer Clothing.*—Clothing collected (tunics, trousers, and cardigans) ironed with hot iron, particularly at seams and forks of trousers, brushed with a hard brush, distributed to men in dressing-room.

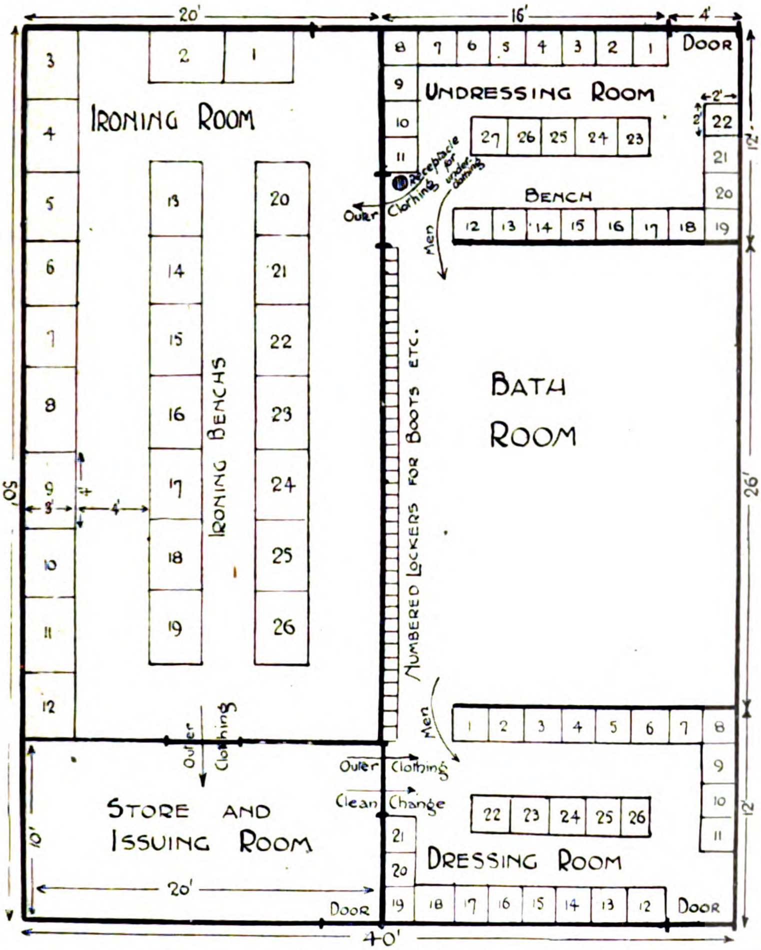

Fig. 10.—Suggested plan for a divisional bath (based upon one now working at the Front). Certain building questions—e.g., lighting—are not discussed.

For the Trenches.—While a unit occupies a trench it should be the duty of a man set apart for the work to see that an adequate supply of insecticides is available for distribution to the men and for general use in the dug-outs. Company officers should see that their men take the necessary precautions against the pest.

For Billets.—This applies particularly to infantry in the rest areas and to isolated units, such as ammunition columns and infantry transport :—

(1) Men should be afforded set times for the express purpose of inspecting their clothes.

(2) A general inspection by the company officer or medical officer is recommended at least once a week, but men of known unclean habits require special attention, if only for the sake of their comrades.

(3) A keen look-out for cases acting as bad lice-carriers should be maintained and the men dealt with speedily.

(4) In addition to existing methods for maintaining clean billets, all old clothing should be removed. Floors and skirting boards should be washed with soapy water to which has been added crude oil and cresol.

(5) If bathing and changing facilities do not exist, the ironing of garments should still be attempted.

For Hospitals.—These remarks apply particularly to hospitals and rest stations carried on by field ambulances, where conditions are frequently difficult.

Even if patients are retained for one night, some measures should be employed. When possible a patient should bath, have a change of underclothing, and have the outer garments ironed.

None of these recommendations are difficult in themselves. The real difficulties are in the regular and persistent use of the methods during exceptional and trying circumstances. For troops living in billets and hospitals the work is feasible, but for infantrymen matters are more difficult. It is necessary, however, to emphasize that the most effective measures may be carried on while men are out of the trenches. In the trenches the work necessary is reduced to the regular distribution and use of insecticides.

To conclude, the matters of cardinal importance are, firstly, that a definite plan of campaign be formulated, and, secondly, that the plan be followed up vigorously by the work of proficient men. It is not so much a problem of pure science, as one of common-sense management.

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FLY-TRAPS FOR CAMPS, HOSPITAL PRECINCTS AND TRENCH AREAS.

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There can be no doubt that the best way of combating the plague of flies is to deal with their breeding-places. Unfortunately, in many instances it is not possible to do so thoroughly, and this is specially true of Egypt. Here, while flies can very largely be prevented from breeding within the precincts of a camp or, if they have laid eggs, say in horse manure, can readily be killed in their developmental stages, it is too often impossible to control countless breeding-places in the immediate vicinity. As a rule, such places take the form of human ordure, the native easing himself in the open where it pleases him, while if there are villages close at hand many other collections of filth suitable for oviposition are certain to be present. Hence in Egypt and similar countries it is advantageous to wage war against the adult flies. This is true also of trench areas, where the breeding-places of flies, more especially of *Calliphora*, *Lucilia* and *Sarcophagidæ* are frequently inaccessible. There are, as is well-known, many ways of killing the winged insects, but a consideration of the state of the cookhouses at M., which, while supposed to be fly-proof, were, as a rule, veritable fly-traps, led me to construct, in August, 1915, a model fly-trap along certain lines. It was fairly successful in catching flies, but the advent of cold weather and other causes brought my experiments to an end for a time. When in England on sick leave I explained my ideas to Mr. F. M. Howlett, the well-known Indian entomologist. He thought that the work should be continued, and suggested heating the traps, so that, early in the day, and more especially at the very beginning of the fly season, they would be more attractive to flies than any other places in the immediate neighbourhood. On my return to Egypt in January I consulted Mr. W. H. McLean, Chief Engineer, Municipal Section, Ministry of Interior, Egyptian Government, with whom I had been long associated in sanitary work at Khartoum and who had already given me some help in connexion with the idea. He kindly entered fully into the question, proposed some modifications and prepared drawings to scale. Fortunately, at this stage we got into

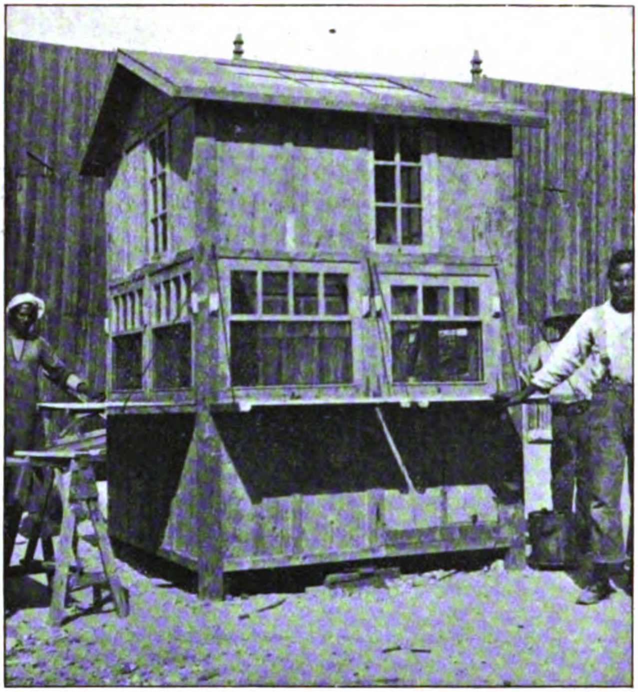


FIG. 1.—Large form in action.

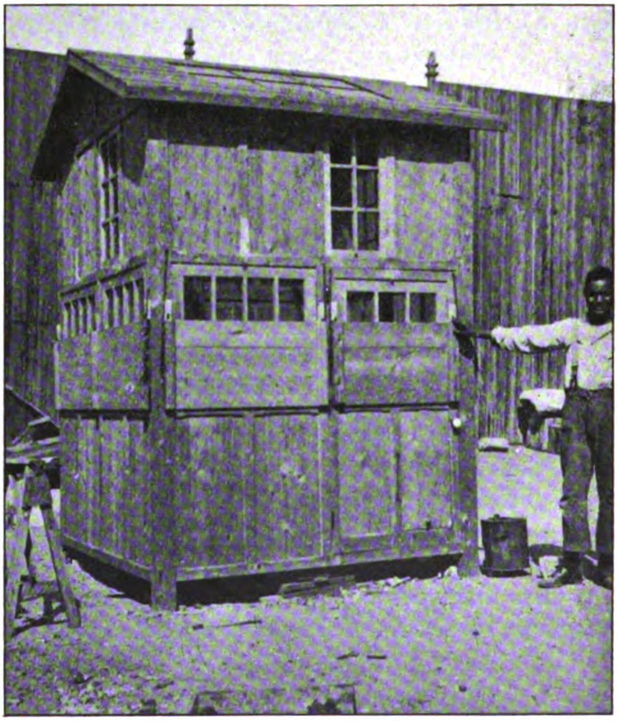


FIG. 2.—Large form closed for fumigation.

touch with Mr. Smith, Manager of Luna Park, Heliopolis, who took up the construction of fly-traps with the greatest energy and enthusiasm and furnished some very useful suggestions, which are embodied in the types now to be described. These are three in number, as will be seen from the accompanying illustrations and may be classed as large, intermediate and small. Though they

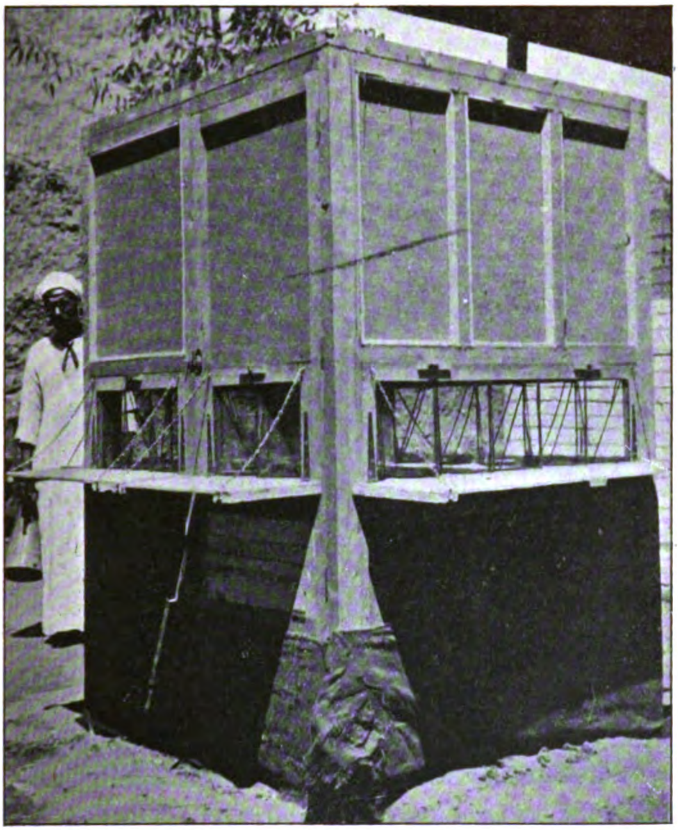


Fig. 3.—Intermediate form in action.

vary as regards size, material and cost, they are alike in all essential particulars, and act in a similar manner, flies entering through slits under wire netting. The large form was first constructed, being built of wood, glass and wire gauze. Its appearance is sufficiently well shown in figs. 1 and 2. The wooden shutter shelves are a conspicuous feature, and this fly-hut, as it may be called, proved very successful, trapping large numbers of flies. It is,

however, rather expensive, costing in Egypt from £10 to £12; thus the intermediate portable form shown in figs. 3 and 4 and in the plans is likely to prove more generally useful. A short account of this form and the method of employing it will suffice, save for a few notes on the small type, which is designed for use in the courtyards of hospitals or in trenches.

The intermediate form which is recommended for camps consists of wood, canvas, glass and wire gauze, and may with

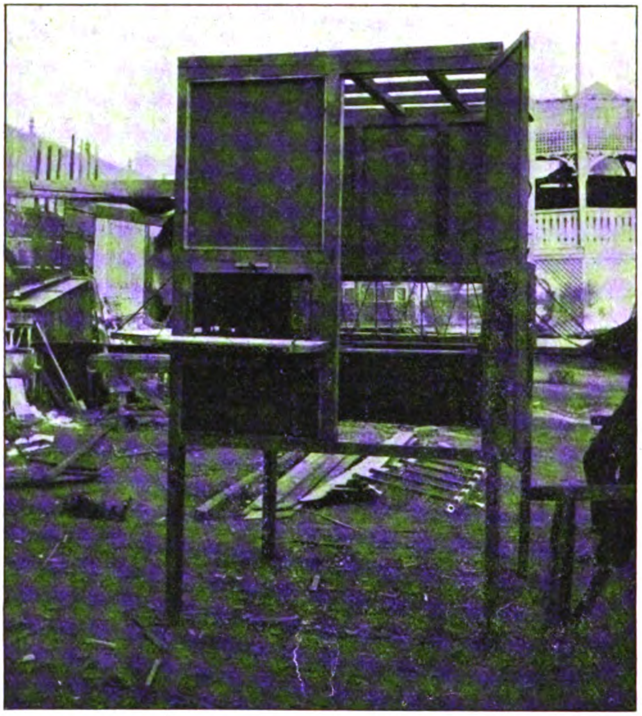


FIG. 4.—Intermediate form, showing glass panes in roofs.

advantage be painted white both inside and out. It can be built in Egypt at a cost of from £4 to £4 10s.—depending on the number constructed at one time. If there is any difficulty in getting panes of glass for the roof squares of white calico may be employed, but it is a great advantage to use glass when it can be obtained. The weight of the trap packed for transport is ninety-six kilogrammes and it requires very little attention. Its powers of attraction depend on three main factors—i.e., the fact that it is well lighted,

the fact that the air in its interior is warmed by means of the glass roof or, if necessary, by using a small native charcoal stove, and the fact that it can be baited with material most attractive to flies. No doubt, also, the presence of flies in the trap serves to attract others to it. It is so constructed that, while the flies which flock to it in thousands readily find a means of entering, very few of them escape provided the trap is properly constructed and operated. The few that may escape through the slits do not matter so long as any dangerous bait which may be used in the trap is covered with wire gauze or muslin. As a matter of fact very few flies do leave the trap once they have properly entered it, for they find it is all they desire in the way of food, warmth, light and shelter.

If the morning is cold and the sun hidden the trap may be artificially heated, for as has been stated it is useful to make it more attractive than surrounding places early in the day. As a rule, however, in a country like Egypt it is not necessary to employ the stove—the glass roof does all that is required in this direction, provided the trap is placed in a bright and sunny place. The legs of the trap should be sunk in the ground, which forms the floor, the interspaces being banked up with sand or covered in by sacking. If desired a floor can easily be provided.

As regards bait, it is best to place the less offensive forms, such as jam, marmalade, milk and sugar, used damp tea-leaves, &c., cheese, a paste made of lentils, which is very effective, on the shelf running round the interior of the trap. Preserves can be spread on pieces of cardboard; milk, lentil paste, cheese, tea-leaves, placed in flat tins or other receptacles. Boards can be stretched from shelf to shelf, and on those shelves chicken entrails (an exceedingly attractive form of bait), fish refuse and pieces of raw meat should be set, while, if desired, a tray of fresh manure can be placed on the ground forming the floor, and a receptacle containing human excrement carefully protected by meshing from the flies, can also be introduced. It will be found that the shutter shelves outside the trap form excellent alighting grounds for the insects, which soon find their way through the slits. The free end of the wire gauze, immediately above these, is turned up or continued out into the trap as a kind of ledge, and so helps to prevent the insects from escaping.

Once this type of trap is in operation it can be left alone, except when it is advisable on windy days to close the shutters on the windward side and save when it is necessary to clear out the old

bait and bait afresh, or when the number of flies is so great that they must be killed off. If left alone many of them die owing to the great heat of the trap. (Indeed, it may sometimes be necessary, in a country like Egypt, to mitigate the heat by covering the glass roof with a piece of sacking or similar material.) If, however, it is considered desirable to get rid of a catch, the trap can be readily fumigated by closing the shutters and introducing, by means of the door, the charcoal stove with an enamel plate or dish placed on the top of it. Keating's powder is then poured on to the plate or into the dish and the resultant fumes of

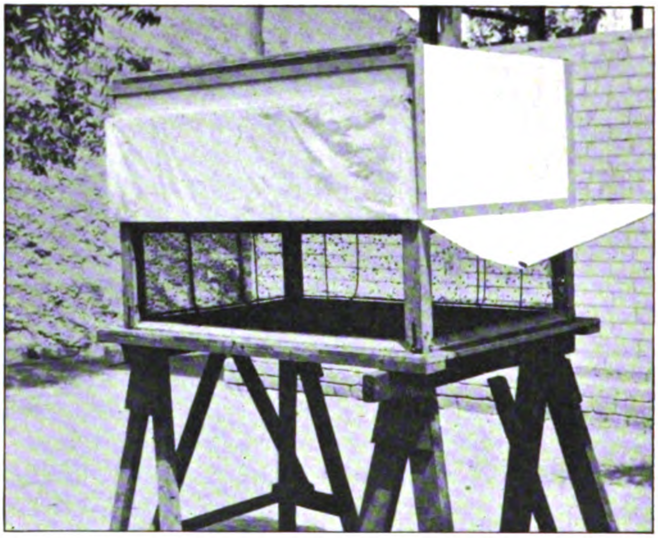


FIG. 5.—Small form in action, showing calico shutter partly lowered. Note flies on wire mesh.

pyrethrum soon destroy the flies; cresol can be used for the purpose, or a mixture of phenol and camphor. If the fumigation is properly carried out there should be no danger of fire. It is best to fumigate in the evening when the flies have settled down for the night on the roof and walls, and this is also the most suitable time for changing the bait.

If a trap without a floor has been employed, and it has been considered advisable to shift it to another locality, it is well to examine the ground over which it has stood to make sure that no oviposition has taken place, and that it does not harbour fly-larvæ.

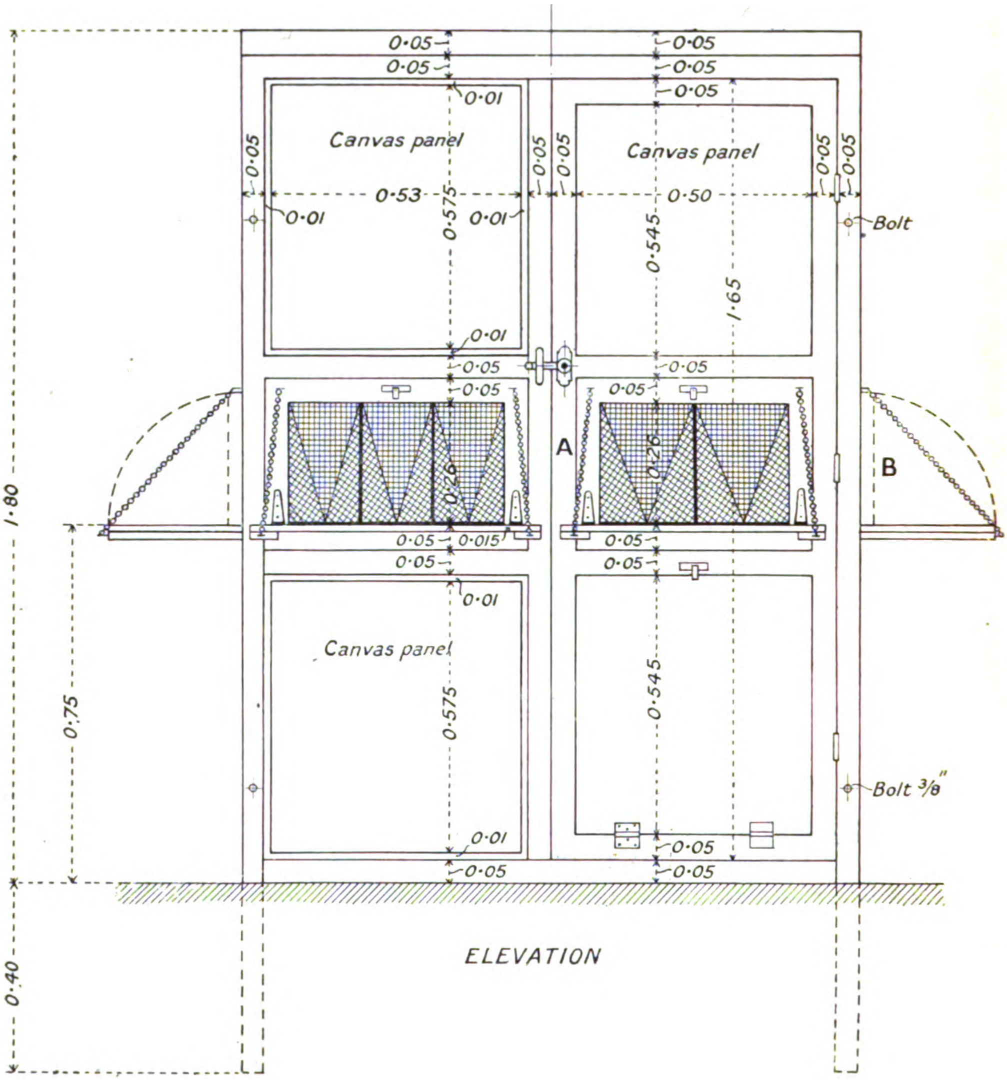
If this is the case, it should be drenched with crude oil or a five per cent solution of cresol.

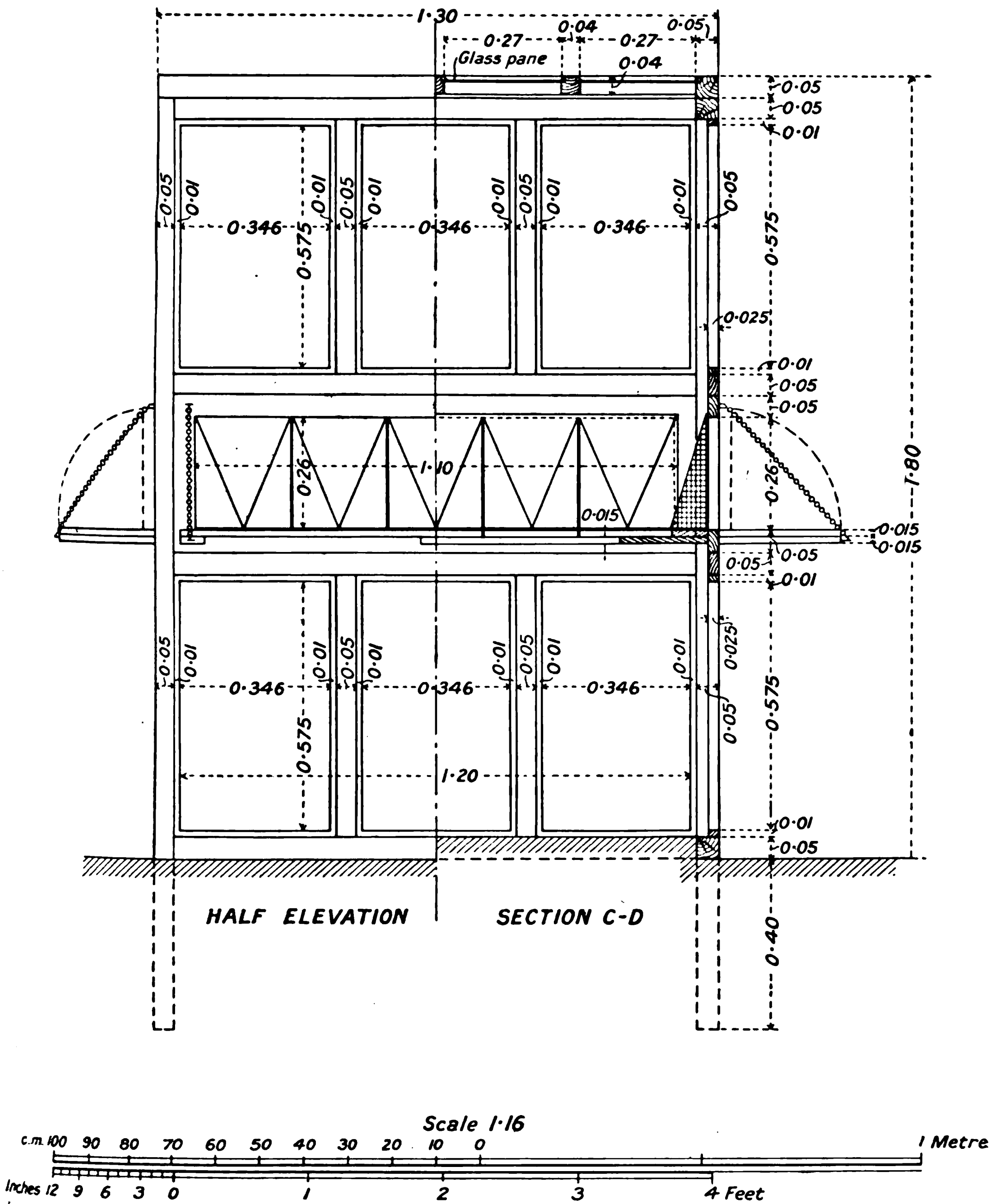
The small form (fig. 5) designed by Mr. Smith merely consists of a wooden framework over which white calico is stretched and an arrangement of wire gauze resembling that in the other types, save that the central part of each section is not recessed. (It is doubtful if this recession is really any advantage, and it makes the construction slightly more difficult.) The cage, for it is little more, is fastened to a board which projects beyond it, and from which it can easily be detached. The board forms the floor on which the bait is placed, and a small sloping alighting shelf is provided to facilitate the entrance of flies into the trap. It leads up to the slit below the wire gauze. A door is present in the latter for the insertion of the simple apparatus for fumigation. A pattern in use at the New Zealand Hospital, Abassia, is fitted with a sliding drawer or tray for this purpose. There are calico shutters which, when open, lie back against the sides of the trap, and are lowered and fixed in position as desired. When the flies have been killed—and in this type of trap it is essential to fumigate the day's catch every evening—the cage is lifted off the board, and the latter cleaned of dead flies and old bait. The trap complete costs about 12s. Like the large type, the intermediate and small forms have been tested at Luna Park, Heliopolis, and have been found rapidly to catch very large numbers of flies, including *Musca domestica*, *Fannia canicularis*, and various species of *Calliphora*, *Lucilia*, and *Sarcophaga*.

The fact that blue-bottles, green-bottles, and carcass flies flock into the small trap when properly baited would seem to show that it might with great advantage be employed in the trenches in France and elsewhere during the summer and autumn. As stated, the flies should be killed off every evening, for the small baits in this trap soon dry up or are devoured, and thereafter the flies tend to leave it because, not having a glass roof, it is apt to be too shady. An objection that may be raised to all these traps is that they will attract flies from outside to the area in which they are operating. This is certainly the case, though my observations have not proceeded sufficiently far to enable me to say to what extent it occurs. The objection, however, is not valid, for flies attracted in this way do not scatter themselves about the area, but throng to the trap and quickly enter it. Hence the net result is wholly to the good, for it must be remembered that not only can vast numbers of flies be destroyed by a liberal use of these traps, but all potential

DESIGN FOR A FLY-TRAP.

Intermediate form for use in Camps.

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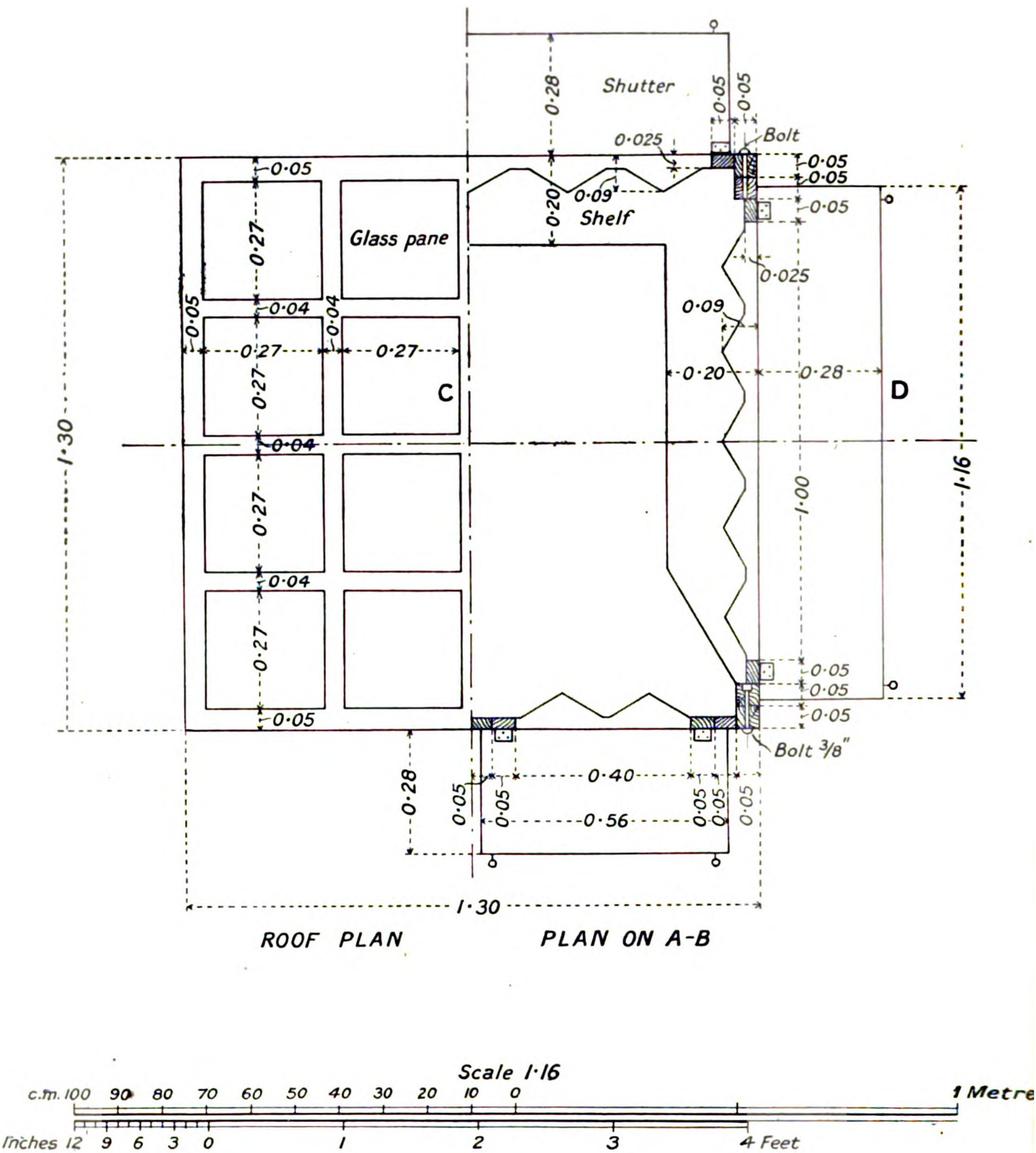
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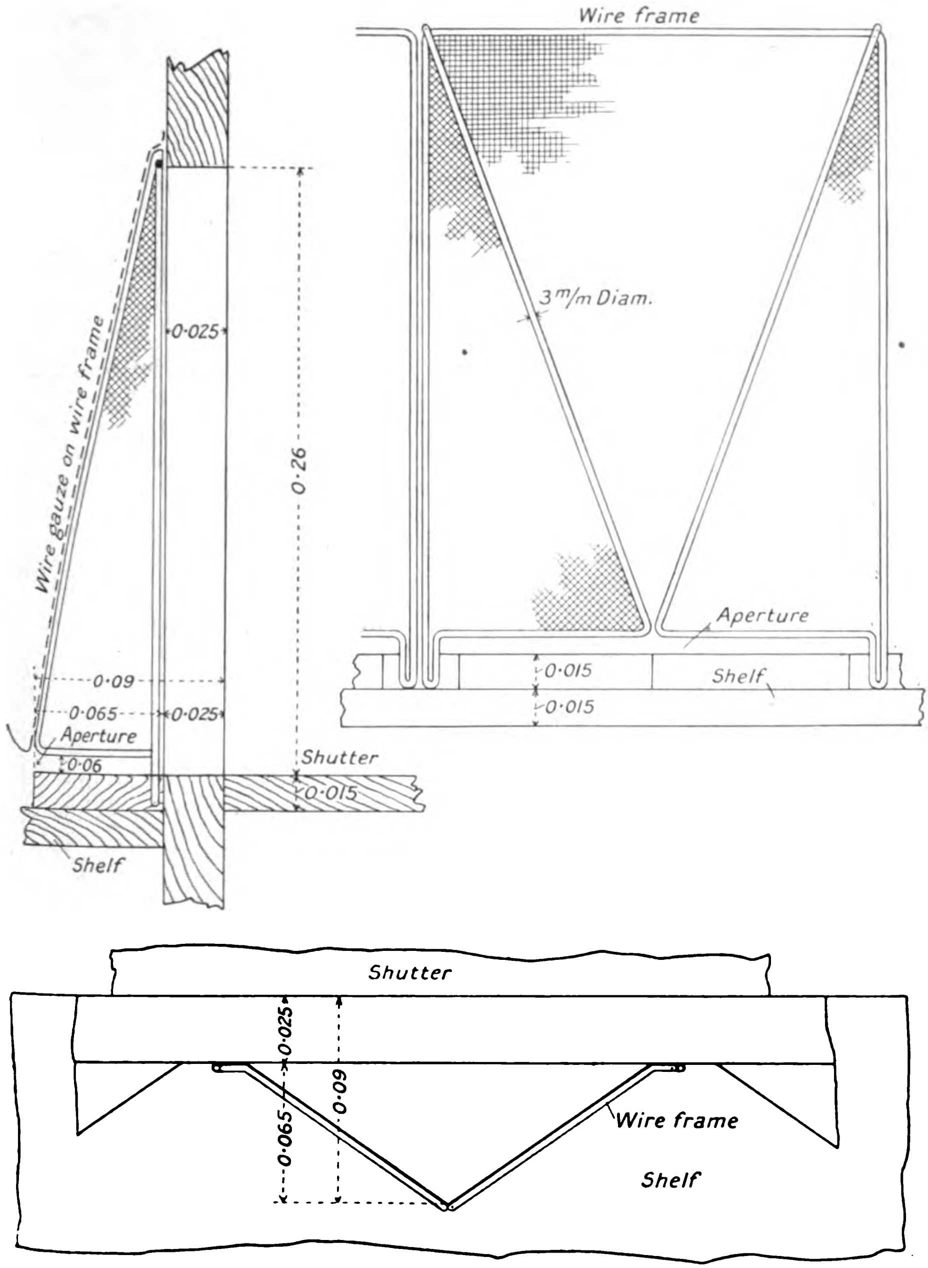

DETAIL OF TRAP
Half full size

breeders amongst these flies are slain and a huge fly population prevented developing. Further, many of the flies caught are actual, and all are possible carriers of disease. This is specially important so far as Egypt is concerned—at any rate in the light of the recent researches and discoveries of Lieutenant-Colonel C. M. Wenyon, R.A.M.C., and Captain F. W. O'Connor, R.A.M.C.,[1] on the rôle of flies as vectors of the cysts of *Entamœba histolytica*. Lieutenant-Colonel Wenyon, who has been testing one of the intermediate forms of traps at No. — General Hospital, writes to say that in flies entering it he has found the living cysts of *E. histolytica*, *E. coli*, and *Lamblia intestinalis*, besides the ova of various helminths, including the lateral-spined egg of *Schistosoma hæmatobium*. In twenty-four working hours this trap may easily catch 10,000 flies—with what benefit to the community a little reflection will show.

Traps of one or other type are in use at several hospitals in C. and A., and an intermediate form is at work in a camp area at S. A special test is being made at the Infectious Diseases Hospital, A., to see what effect small traps will have on the flies, which literally swarm upon the native patients in the typhus, relapsing fever and small-pox wards, and with which it is very difficult to cope by any of the ordinary methods. In due time the merits and demerits of these traps will be more clearly defined, and probably further useful modifications will be suggested. Fly-trapping in this way will never solve the great fly problem in Egypt or anywhere else, but these traps, if carefully and intelligently used, should certainly prove themselves useful auxiliaries in the campaign against the disease-carrying fly. It is probable also that their use will add to the comfort and well-being of our troops in hospitals, camps, and trenches.

I would specially acknowledge my indebtedness to Surgeon-General Howse, V.C., C.B., Australian Army Medical Corps, and to the Australian Red Cross Society, without whose kind assistance it would not have been possible to get the necessary experiments carried out at Luna Park.

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[1] Memorandum issued by the Medical Advisory Committee, Mediterranean area, April, 1916.

THE TREATMENT OF GONORRHŒA WITH INTRA-MUSCULAR INJECTIONS OF MERCURY SUCCINIMIDE AND WITH SOME OTHER MERCURIAL COMPOUNDS.

By Lieutenant-Colonel L. W. HARRISON, D.S.O.
Royal Army Medical Corps.

Nobody with experience of it will deny that gonorrhœa is a tantalizing and unsatisfactory disease to treat. The remedies which have been suggested for it are innumerable. Many of these have been vaunted as certain cures in a minimum time, yet most of us find irrigation with potassium permanganate as good as anything and better than most for routine work, and this is our best commentary on them.

Looking at the question from another point of view, the injunction to the patient to go quietly for months, not to drink beer or similar beverages, nor to indulge in sexual intercourse, are tacit admissions that we do not believe we have defeated the gonococcus when the patient leaves our care. For if we had eradicated the causal micro-organism, what need would there be for these precautions? The urethra would recover quickly enough if it were sterilized. The fact is that in the few weeks during which we are allowed to treat the average case of gonorrhœa we succeed only in calming the urethra down to a toleration of the gonococcus.

The explanation of this unsatisfactory state of affairs is easy when we consider the pathology of gonorrhœa. It lies in two factors—the tendency of the gonococcus to penetrate deeply into the mucous membrane and bury itself in the innumerable gland follicles opening thereon, where it is safe from attack by injection and irrigation, and the fact that the urethral membrane is so sensitive that antiseptics of sufficient strength and penetrating power to reach and destroy the gonococcus cannot be used. The extraordinary persistence of gonococci in the secretions of the eye after an attack of gonorrhœal ophthalmia, in spite of the fact that in this situation the mucous membrane is considerably less sensitive and local conditions infinitely more favourable to the success of local treatment, shows the difficulty in the case of the urethra.

To the writer it has been clear for a long time that we must seek for a remedy for gonorrhœa amongst compounds which will reach the gonococcus directly from the blood. One is the more certain of this from the conviction that gonorrhœa is far more often

a septicæmia than is commonly supposed. The frequent instances which one meets of the gonococcus setting up trouble exclusively in a damaged part of the body—a sprained ankle, a damaged finger, or some other odd spot where there is a history of former injury or stress—where one is convinced that but for that local damage the gonorrhœal manifestations would have been confined to the urethra, compel the belief that the gonococcus circulates in the blood of most apparently uncomplicated cases.

Remedies such as sandal-wood oil, copaiba, and the like are probably only other means of applying local treatment. At any rate, without contesting their virtues as adjuncts to the treatment, it is safe to say that none of them is a specific for gonorrhœa.

Specific antibodies induced by the injection of vaccine, though helpful, are uncertain in their action. Possibly this is because the antibody production is inadequate; possibly, also, human beings, like animals, vary greatly in their response to some antigens.

Searching for a specific for gonorrhœa, my attention was recently attracted by the paper of B. L. Wright on "The Treatment of Vegetable Parasitic Origin by Deep Injections of Mercury" (*New York Medical Record*, February 22, 1913), in which excellent results were claimed from intramuscular injections of mercury succinimide.

I had frequently noticed in cases of combined gonorrhœa and syphilis that by the time the first course of mercury and salvarsan treatment had finished (at that time in about a month) the patient was apparently cured of his gonorrhœa. Thinking that salvarsan might possibly have been the determining factor in the cure of these cases, I had, in fact, treated a number of intractable cases of gonorrhœa with this remedy, but without success. The cases so treated were certainly very persistent ones, however, and of the type which subsequently proved resistant to mercury succinimide, so that it would not be fair to assume from this failure that salvarsan has no beneficial effect on gonorrhœa.

The observation referred to made one ripe for acceptance of the claims put forward by Wright for mercury succinimide, and after a preliminary trial which proved promising an extensive test of this remedy was instituted in a venereal hospital where I happened to supervise the treatment. For the results detailed below I am indebted to the medical officers under whose immediate care the patients were, and who administered the treatment. My own part in the investigation was simply that of instigator and adviser.

The mercury succinimide was administered in a five per cent solution either in three doses of fifty milligrammes or two of

seventy-five milligrammes at intervals of three days. In certain cases a second course of three injections was given after about ten days. Local treatment by irrigations or injections, and all other routine measures for the treatment of gonorrhœa, were continued as before.

In a substantial proportion of the cases the immediate effects were so striking as to produce a marked impression in favour of the remedy, which very quickly became popular with medical officers and patients alike. Since each medical officer was treating from 250 to 400 patients, it may be assumed that any impressions gathered from the effects of a change of treatment would be well founded. In the cases which responded well the change from acute and profuse purulent discharge to no discharge at all in considerably less time than the average was very marked. In other cases the discharge became quickly scanty and muco-purulent, but remained in this condition for a long time, while in a small minority the treatment appeared to have no effect whatever. In a certain number of these cases a second course of injections was given, but these did not prove a great success.

A sufficient number of bacteriological examinations of the urethral secretion had not been made up to the time of writing to justify any opinion as to the bactericidal properties of mercury succinimide when administered in this way. In a small series of examinations the gonococci seemed to disappear from microscopical view, apparently *pari passu* with the improvement clinically, but inability to find gonococci in a few series of urethral smears from the same cases by no means indicates their total disappearance from the urethras concerned, and further work on this point is necessary before any judgment can be given.

The urethral discharge (taken under precautions to exclude urine) was found to contain mercury by Pte. L. Hulls, to whom I am greatly indebted for valuable work in this and other chemical investigations.

The side-effects of mercury succinimide are, on the whole, mild. Most cases suffer no more inconvenience than a little temporary soreness at the site of the injection, which does not interfere with their getting about. In one of the 3,467 cases treated a small abscess developed at the site of injection, and in another a small superficial slough resulted. Both of these were probably due to a little of the solution having been injected into the skin or sub-cutaneous tissues, not intramuscularly. In a small proportion of cases the injections were followed by diarrhœa, and some of these

suffered from mild colitis, with blood and mucus in the stools, but these symptoms yielded to treatment in a few days. Mild stomatitis occurred in a fairly substantial number of the cases treated, especially in those with carious teeth, which were very common amongst the patients treated. Hæmaturia and albuminuria occurred in six of the cases, but in a mild degree, and yielded quickly to treatment. Altogether, side-effects gave rise to no anxiety.

Before detailing the total results obtained so far, it is necessary to explain that the conditions were considerably more adverse to rapid cure and discharge from hospital than obtain in peace time. Practically all the cases came under treatment for the first time more than a week from the commencement of symptoms, and in the meantime had been exposed to active service conditions of fatigue and exposure, which assisted the disease to obtain a good foothold. Quite ten per cent of the cases were admitted with such complications as epididymitis, arthritis and prostatic abscess, all of them conditions which tend to raise the general average duration under treatment. Before discharge to duty the patients were left for some days without treatment. On discharge to convalescent camp they were examined by a senior officer other than their own, and this examination was repeated on final discharge to duty, while at their base depôts they were again examined by a medical officer, who did not hesitate to return them on the least suspicion of a urethral discharge being apparent.

On return to duty they were exposed to conditions favourable to a return of their disease unless this had been thoroughly quieted down—cold, exposure and fatigue (with the help, perhaps, of such distractions as beer and sexual intercourse), and it was necessary to be reasonably sure of the cases not relapsing quickly before returning them to duty. For these reasons patients had to be kept under treatment and observation much longer than is considered necessary in peace time, when patients report much earlier, subsequent conditions are not so adverse, and a relapse means simply a return from barracks to hospital in the same station. It is necessary to explain these details as otherwise an unjust impression of the results detailed below would be derived from the fact that the duration of treatment and observation has all round been longer than in peace time.

The results were as follows: Out of 3,467 cases of gonorrhœa treated with succinimide of mercury, 2,026 were returned to duty in an average of 30·38 days from the date of the first injection; of those returned to duty 829 went in less than 25 days and 1,197 in more than this time.

Of the cases returned to duty 138, or 6·8 per cent, were re-admitted for relapse. This compares with 10·08 per cent of relapses in 9,762 cases treated under practically identical conditions, but without succinimide. It is not sufficiently below it (considering that it relates to only a quarter of the time) to warrant a claim to any advantage on this score.

Out of the balance of 1,441 still under treatment at the time of writing, 633 had been less than twenty days, 251 from twenty to thirty days, and 557 more than thirty days under treatment.

The average time spent under treatment and observation from date of admission to that of discharge to full duty by the 2,026 cases was 41·15 days, which compares with an average of 49·88 days for the non-succinimide cases referred to above.

The gain from the use of mercury succinimide (8·73 days) does not appear very striking, and it is necessary to explain that included in the succinimide results are practically all the chronic old complicated cases which had been in hospital a considerable time before being treated with the succinimide. This is shown by the fact that although it quickly became routine to commence injections on the day after admission, yet the average time spent in hospital by all the above-mentioned cases from admission to date of first injection was 10·77 days. In an earlier series, included in the above, which contained a rather larger proportion of fresh cases (the average from day of admission to first injection being 9·45 days), out of 2,366 cases which had received the treatment, 869 were returned to duty in an average of 25·26 days from the first injection, or 34·71 days from first admission, 249 of the balance still under treatment at the time of collecting the results having by then been more than twenty-eight days under treatment since the date of the first injection.

On the whole, the results indicate that intramuscular injections of mercury succinimide are a useful means of shortening the duration of gonorrhœa cases under treatment and have effected a fairly substantial reduction of total wastage from this disease. As stated, the best results appear to follow injection in early acute cases, and for the reasons already given an improvement may be anticipated when a larger proportion of cases is treated immediately after admission to hospital.

At the same time it must be said that mercury succinimide does not fulfil one's ideal of a specific for gonorrhœa, and my object in writing this paper has been simply to suggest that this compound may be one end of a thread leading to the discovery of such a specific.

Other mercurial compounds have been tried in the hope of finding one which is better than succinimide, but so far without success. The preparations tried were mercury perchloride, calomel, mercury salicylate, "énesol," "anogon," "argulan," and colloid mercury (Dausse). Those at present under trial are bibromide and benzoate, both of which are promising better than the ones just mentioned.

I am greatly indebted to the Medical Research Committee, who very kindly supplied me with a substantial amount of mercury succinimide when it seemed impossible to obtain any; to the medical officers of the hospital where this work was carried out for their very valuable co-operation; and to Serjt. Andre, R.A.M.C., who spent many hours' overtime in collecting and compiling the results.

THE SURGICAL AND ANTISEPTIC VALUES OF HYPOCHLOROUS ACID (EUSOL).

By Captain JOHN FRASER,

and

Captain H. J. BATES,

Royal Army Medical Corps.

In June, 1915, we first began to make use of 0·5 per cent hypochlorous acid (eusol) as an antiseptic. Six months have now elapsed and it may be of interest to summarize its relative values. Previous to adopting hypochlorous acid, use and experiment had been made of all the better-known antiseptics, and therefore the ultimate adoption of a single antiseptic was of interest, as the comparison brought more clearly into view the relative advantages of the more newly employed method. For facility of description the use of hypochlorous acid (eusol) will be described under two headings :—

(*a*) General use—in simple general wound treatment.

(*b*) Special use—in special wounds, or in special body localities or diseases.

It is unnecessary to enter into any detail regarding the preparation of the solution of hypochlorous acid (eusol); for such details one is referred to the paper by Professor Lorrain Smith and others in the *British Medical Journal* of July 24, 1915.

Briefly our method of preparation was as follows: In a Winchester quart bottle twenty-seven grammes of dry bleaching powder were placed, and to this one litre of water was added; the mixture was shaken, and twenty-seven grammes of boric acid were added; the bottle was now filled with water, the solution was thoroughly shaken, allowed to stand for a few hours, and then filtered through cotton wool. The clear solution is eusol; it is slightly alkaline to litmus and it contains approximately 0·5 per cent hypochlorous acid. The solution was stocked in air-tight stone jars.

(*a*) General Uses.

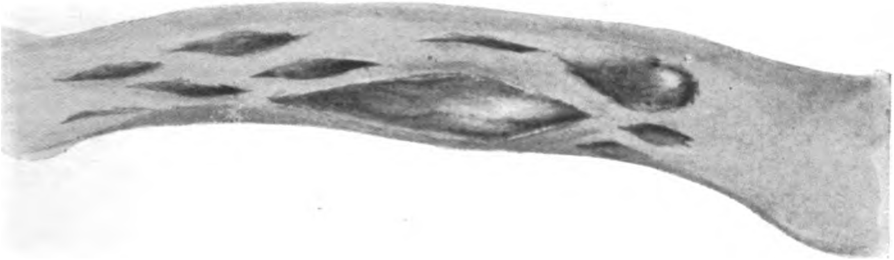
In war work it may be accepted as a general principle that every wound is an infected one, and naturally the further principle follows: that the treatment of such wounds must be adopted on antiseptic lines. In dealing with such cases two ideals are kept in view: thorough drainage of the part, and as complete disinfection

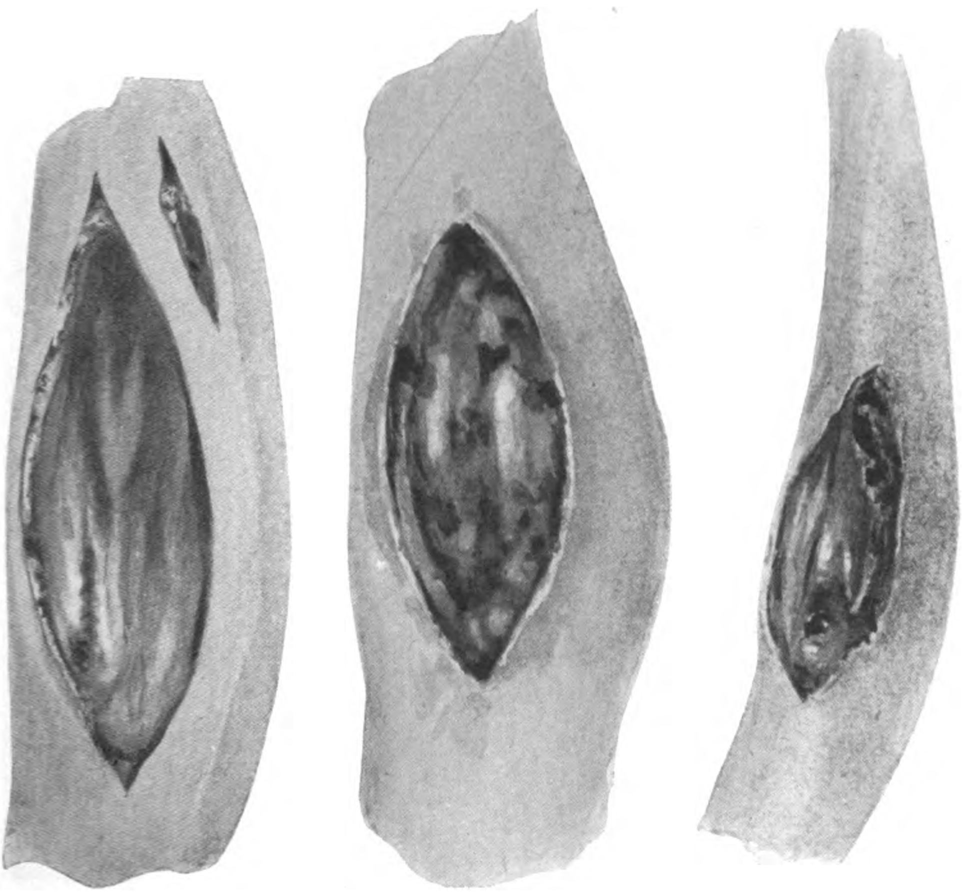
of the wound as is possible. The efficient antiseptic is one which, while it exerts its antiseptic action, does not devitalize the body tissues; it seems to us that in the hypochlorous acid solution (eusol) we have as nearly as possible the ideal antiseptic.

In an ordinary gunshot or stab wound our procedure has been to open up the wound as thoroughly as possible; its interstices and crevices are thoroughly washed out with eusol, the solution being warmed to body temperature. A laterally perforated tube is passed into the wound, and around the tube, between it and the wound edges, gauze soaked in warm eusol is lightly packed, while over the wound surface similarly treated gauze is placed. The frequency of dressing depends on the condition of the wound, if there be a gross infection the dressing is repeated every four hours; in lighter infections the interval is correspondingly lengthened. It is not necessary to change the tube or even the surrounding gauze at each subsequent dressing; it is often sufficient to inject fresh eusol into the tube from which it is dispersed through the lateral openings into the surrounding gauze. We have found it essential, however, to change the tube at least once in twenty-four hours, and the gauze at least twice. It has been our experience that under this treatment infection rapidly disappears from the wound. It is a striking fact that suppuration does not occur, or if it has been present in the wound, it disappears very rapidly after application of the solution. A suggestion has been made to us that this is a disadvantage as the excretion of deleterious matter is prevented; we have not observed any such disadvantage, and probably disinfection and elimination of toxin are so thorough that any such excretion is unnecessary. Healthy granulation tissue begins to appear within fifty-six hours, and having appeared it grows with remarkable rapidity. When the stage of granulation tissue formation has been reached we have found it advantageous to intermit the eusol dressing for periods of twenty-four hours with dressings of hypertonic saline solution.

At this point it is important to discuss the disadvantages or objections which may be raised to this method of treatment. Four of these have at one time or another presented themselves, but, on investigation, they have all proved negligible. They are:—

(1) *Pain in the Wound.*—When the stage of granulation tissue formation has been reached, a stinging, burning pain is complained of after the application of the eusol, which lasts for a period of about thirty minutes. We have never noted that the pain possessed any real degree of severity, and probably it is less than that produced by almost any other variety of antiseptic.





To illustrate "The Surgical and Antiseptic Values of Hypochlorous Acid (Eusol)," by Captain JOHN FRASER and Captain H. J. BATES, R.A.M.C.

(2) *Irritation of the Surrounding Skin.*—In only a single instance out of an experience of several hundreds of cases have we seen this occur. We believe that reasonably frequent changing of the dressing entirely prevents its occurrence.

(3) *Arrest of the Wound Secretion.*—Undoubtedly throughout the first three days of the application of the antiseptic the wound under treatment is drier than one would expect in such a wound, and, as we have mentioned, this fact has been quoted to us as a disadvantage. We have never found any disadvantage arising from this.

(4) *The Surrounding Skin becomes Dirty.*—Eusol mixed with blood pigment forms a greenish compound on the skin which is dirty in appearance and somewhat difficult to remove, but the compound is assuredly an antiseptic one, and after some days it can be washed away. No other objections have been quoted to or observed by us.

(*b*) Special Uses.

Gas Gangrene.—One of the most dreaded complications which arises in modern warfare is the infection of a wound with a gas-producing organism. Wounds inflicted in warfare under modern conditions especially as regards locality would appear to be particularly liable to such infection. In these cases eusol has proved of inestimable benefit. A summary of experience in this connection was published in the *British Medical Journal* of October 9, 1915. The infected wound is treated on the scheme which we outlined in describing the general treatment of wounds, and special attention is paid to frequent changing of the dressing. The usual experience is that the infection is early and completely arrested. Occasionally cases of this description come under our care so late that local measures are insufficient, and amputation is the only possible procedure. In order to procure the best stump, it is frequently necessary to cut the flaps so that they pass through what appears to be infected tissue. We have frequently done this with impunity since we adopted the use of hypochlorous acid. It is sufficient to open up the gas-infected area, and wash it out thoroughly with the antiseptic.

Compound Fractures.—The persistence of infection in cases of compound fracture is notorious, and we have noted great improvement in the treatment of such cases; the infection early disappears, and further measures of treatment can be more readily undertaken. Further, the absence of suppuration and the arrest of infection

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have greatly reduced the necrosis and subsequent sequestrum formation which is so troublesome.

Joints.—In severe cases, where the joint is disintegrated, we have had the same experience as in cases of compound fracture. Special mention must be made of small penetrating wounds of joints causing a hæmarthrosis; these are almost invariably infected; bits of clothing have been recovered from the joint cavity, and the general and local conditions may point to the presence of pus. It is our practice at once to open and drain the joint, and irrigate with warm eusol. The inflammation has quickly subsided, and the joint has shown no signs of the formation of adhesions. In cases where the cartilage has been visible, no granulations or appearances of destruction have been seen on its surface.

Cranial Surgery.—A large proportion of the cases with which we have to deal are compound fractures of the skull, associated usually with extensive injury to the underlying brain. Almost without exception the cases are infected and, we believe, that the main degree of the mortality in the more recent type of case is due to a progressive septic change in the brain.

While the operation is proceeding, we have found benefit by having a continuous irrigation of the tissues with eusol: the warm fluid is suspended in a vessel above the patient and continuous irrigation is thus ensured. In all subsequent draining and dressing the same antiseptic is employed. By these means we believe we have reduced the degree of septicity in such cases.

Chest Surgery. Empyema.—We find that we can with perfect safety irrigate the pleural cavity with a warm solution of eusol. The cases in which we have used the method have been those of infected bullet or shell wounds with subsequent empyemata. No doubt the cavity was localized where the irrigation was employed. Subsequent to the use of the antiseptic the discharge invariably diminishes and disappears more quickly than we had previously experienced. It seems to us that in these cases its use is ideal and we have had no experience of the complications which are usually so dreaded from adopting such a procedure.

Abdominal Surgery.—We have had experience of this antiseptic in three different types of cases under this heading—in appendix abscesses, in general peritonitis, and in cases of bullet wounds of intestine or other viscera. Before using the antiseptic in the peritoneal cavity we carried out some experiments on rabbits, in which we opened the abdominal cavity and thoroughly washed its surface with eusol, leaving a certain amount *in situ* before closing

the wound. Subsequent examination showed no deleterious effect, not even in the shape of an adhesion.

In the treatment of appendix abscesses we have had satisfactory results: the discharge was arrested and healing proportionately hastened.

In regard to general peritonitis we speak with great diffidence, as our experience with the antiseptic in such cases has been limited to a single example. Briefly, the facts are as follows: A man was admitted to hospital who, four days previously, had had an onset of acute appendicitis. When admitted he was found to be suffering from acute general peritonitis; the appendix was ruptured and extensively gangrenous; the abdominal cavity was actually as full of pus as it could be, and there was a large subphrenic collection on the right side. Drainage was established in the pouch of Douglas in both iliac fossæ in the right kidney pouch and in the right subphrenic region. Twelve hours later irrigation with eusol was carried out through the various drainage tubes. At the next dressing it was noted that the discharge had entirely altered; it was now almost clear and up to the period of writing, i.e., four days after operation—the discharge has practically ceased, while the patient is making a satisfactory recovery.[1] But as we have said we quote the result with great diffidence, as our experience in this relationship is limited and the result we have quoted may be merely a coincidence.

Cases of perforating wounds of the abdomen which have been operated on and which require subsequent drainage of the peritoneal cavity, we invariably irrigate through the tubes, with very beneficial results.

Urethritis.—Cases of chronic urethritis appeared to be very suitable for treatment with eusol and, consequently, irrigation was carried out with eusol of known strengths (titration being done) 0·17, 0·25, 0 5 per cent hypochlorous acid. In some cases pain was experienced with the strong solution, in the others it was comfortably borne in full strength and proved to be very efficient. The discharge became rapidly less.

In cases of acute urethritis we had not so much success. There was considerable pain and smarting, and the solution appeared to be too irritant for the highly inflamed mucous membrane of the urethra.

Finally, we wish to mention a special use of eusol to which

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[1] This case made a complete and rapid recovery.

reference has been made in a paper by Professors Lorrain Smith and Ritchie and Dr. Rettie (*British Medical Journal*, November 13, 1915)—namely, its value as an intravenous injection in the antagonism of toxæmias.

We have experienced a number of cases of acute toxæmia subsequent to infection of a wound with a gas-producing organism. Hitherto, such toxæmias have been fatal in a considerable proportion of cases. In such cases we now employ intravenous injection of eusol, varying in amount from forty cubic centimetres to seventy cubic centimetres. To the eusol common salt is added in the proportion of 8·5 grammes of salt to the litre of eusol. With this method of treatment we have had most gratifying results. These form the subject of a communication at present in process of publication (*British Medical Journal*, January 15, 1916).

We wish to express our indebtedness to Lieutenant-Colonel Wear, R.A.M.C. (T.), for permission to make use of various cases.

MALINGERING: EXAMINATION OF THE UPPER EXTREMITIES.

By Hon. and Temporary Lieutenant-Colonel Sir JOHN COLLIE, M.D.
Royal Army Medical Corps.

It is a mistake to assume that because a soldier is detected in an obvious over-statement of his case, that he is therefore a malingerer. Most men of this class have little capacity for stating their disabilities clearly, and being naturally anxious to make sure that their complaints will receive adequate attention, they are apt to exaggerate them. Allowances should be made also for their incapacity to express themselves clearly owing to defective education and their diffidence before their superior officers. I have often seen men who, though genuinely deaf enough to render them wholly unfit for active service, think it necessary to act as if they were stone deaf, and thereby prejudice their case.

When all allowances have been made, there are still many who attempt to evade duty by malingering. Those who are not accustomed to dealing with soldiers should therefore treat them very warily when, as so often happens, there is an entire absence of objective signs, and when the whole clinical history is represented by the allegation of subjective sensations. Nine-tenths of the subjective symptoms (not, of course, the physical signs) met with in trifling accidents are the result of auto-suggestion. Lawyers say that circumstantial evidence is often more valuable than direct evidence; the method of a malingerer or a neurasthenic in narrating his symptoms is often more informing than any abnormalities found on physical examination.

Most of those who are doing temporary Army medical duty have had to deal only with private patients, where malingering is practically non-existent. To boast that one never makes mistakes betrays a want of knowledge of human nature; to believe it, proves one's incompetency. The detection of malingering is not so much a question of scientific knowledge as of the personal equation and capacity of the medical examiner.

Most errors in medical work arise from either haste or want of thoroughness when conducting an examination. Thoroughness is the keynote of all examinations which are of any value. In few things does the old adage that "What is worth doing at all is worth doing well" better apply than in a medical examination.

The following observations and simple experiments, which I have found useful in the particular class of work I have been engaged in for many years, may be useful to others :—

Alleged Weakness or Inability to Close the Fist.

The forearm is bared and the soldier's fingers are partially flexed (passively if necessary) on the palm. The examiner, flexing his own fingers, interlocks them with those of the patient, asking him to close his fist, thereby squeezing the examiner's fingers. It is now explained to him that an attempt is to be made to straighten his fingers forcibly and he is directed to resist it. Not infrequently no attempt at resistance is made, and the fingers are straightened with very little if any force.

The examiner should now palpate the anterior surface of the forearm, when he will probably find that the flexor muscles are soft and flabby, not having been put into action. If what has been done is now explained in simple language and he is told how it is now known that he is not really attempting to close his fist, the experiment on a second trial is often found to be successful, and the soldier resists extension of the fingers, showing that their flexors are not powerless.

The success of the malingerer depends upon his skill in filling in the whole picture of his alleged disability, and want of accurate medical and anatomical knowledge leads to his undoing.

The difficulties which beset medical examiners are exemplified by the following somewhat unusual cases of fraud, of a particularly clever nature, which came under my observation not long ago; no credit is due to anyone for having discovered it, inasmuch as the information was vouchsafed by a fellow-patient in the hospital, where the impostor was under treatment.

> A man, aged 29, who had been four years in the public service, complained that his left hand became blue at times and that it felt cold. The condition was diagnosed as Erythromelalgia. As the blueness, etc., persisted at recurring intervals, he was sent to a hospital, where he received electric treatment. Whilst in hospital the unusual symptoms excited much interest, some sympathy, many theories, and an anonymous letter, which ran as follows :—
>
> "I wish to put you behind the scenes with regard to the man you are now treating in this hospital who is supposed to have hurt his shoulder whilst at work. Perhaps, like some other doctors, you cannot understand his case exactly. Let me explain something to you, and then you can get at the root of it all. This patient, by a

simple twist of the shoulder, can put the same in and out of socket at will without the least trouble, this no doubt causing compression of the blood-vessels, hence the root of supposed trouble. You can satisfy yourself of this by noting height of shoulder position of blade-bone in back, etc., when examining. You will also find patient is able to twist and turn arm in any position when in or out of socket; you will find this perhaps a rare and strange incident, but all the same a fact. Perhaps a talk of operating on his trouble will soon cause you to lose your patient.

"Cause: supposed injury whilst on duty.

"Result: invalided and pension.

"This is no idle communication. Trusting you will treat this in absolute confidence is the wish of "A LOVER OF JUSTICE."

The suggestion that the communication was to be treated as confidential was naive, as it was anonymous! I tried to get the patient to dislocate his shoulder for my benefit, but he professed the most profound innocence. He was, however, discharged from the hospital and ordered to resume duty. The fact that he resigned his position in the public service a few weeks afterwards gives colour to the suggestion that he desired to leave the service and that his illness was an attempt to obtain a pension for life.

I made careful inquiry as to his after-history, which was not one of invalidism or idleness.

If an unusual group of symptoms alleged are compatible, it is unwise to disbelieve in their existence until you have thoroughly sifted each separately.

ALLEGED LOSS OF ABILITY TO MOVE THE ELBOW-JOINT.

Slowly flex the elbow-joint and then gently but with an exhibition of force, suddenly attempt to straighten the forearm; when the power is *not* lost there will be an involuntary resistance to extension, due to sudden contraction of the biceps which the simulant, taken unawares, unconsciously exhibits.

ALLEGED INABILITY TO RAISE THE ARM ABOVE THE HEAD.

(1) If, as so frequently happens, it is alleged that there is no power to raise the arm, it is difficult to disprove it, if not genuine. The examination of the shoulder should be completed, and the soldier's attention directed to the examination of his back. He is asked to bare the back and to stand with both hands resting lightly on the back of a chair, and a painstaking examination of his back is made. With a view to doing this thoroughly he should be induced gradually to step backwards away from the chair, still

resting his hands lightly on it. This of necessity extends his arms above his head. The whole body is now in a horizontal position, and the hands are then actually high above his head, although the soldier usually does not recognize it, because he is now in the horizontal instead of the vertical position. Allowance must be made for the support afforded by the chair in considering the *weakness* of the shoulder muscles.

(2) Another method is as follows: The arms are raised at right angles to the body in a horizontal position, and then suddenly all support is withdrawn. If one arm is really incapable of being raised voluntarily, it will drop limply to the side when the support is removed. If there is no real disability the arm sometimes remains in the position in which it has been placed for a second or two, and then is gradually allowed to fall to the side, showing that muscular power is not lost.

Sir Hector Cameron tells the tale of an easily won victory in a difficult shoulder case:—

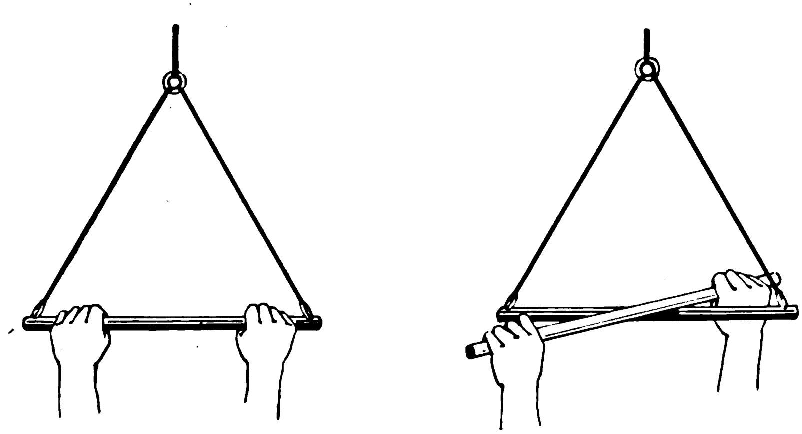
> In the Scottish Courts a witness is always sworn by the judge himself. The ceremony is more imposing than in the English Courts: the judge stands and, with uplifted right hand, orders the witness to do the same and to repeat the oath, sentence by sentence, after him. Not very long ago a witness from the country, who alleged his complete inability to raise his right arm higher than a right angle, sued a wealthy railway company for damages. The case was tried in the High Courts in Edinburgh; the plaintiff was the first witness, and the President of the Court, bedecked with the brilliant robes of his office, suddenly arose and, addressing the plaintiff, ordered him in somewhat stentorian tones to hold up his right hand and to repeat after him the words: "I swear by Almighty God as I shall answer to God in the great day of Judgment," etc.
>
> The scene was so imposing that it brought about a condition that many doctors had failed to effect, for the plaintiff, forgetting his disability, shot his arm high above his head and repeated the oath as requested—and so the case had an unexpected and happy ending!

If it is stated that the arm cannot be raised above a certain level, the exact height should be noted. By insisting that this shall be done several times, the height may sometimes be found to vary. A shoulder-joint, if fixed as the result of severe or chronic arthritis, always shows some atrophy of the deltoid and other muscles in the immediate neighbourhood of the joint. In slight cases this may amount only to flabbiness, but in prolonged cases there is always more or less actual wasting of the muscles. Note whether the alleged pain corresponds to the distribution of nerves. It is a good

plan to watch the facial expression when a joint which is alleged to be painful is being moved; this can sometimes be done unobtrusively by placing the patient in front of a mirror and examining the joint from behind.

The following is a good illustration of the class of case in which nothing but an enforced return to work, in spite of the little disabilities which must attend it, will be effective:—

> A. O. fell through a hole in the floor whilst at work. He alleged that he dislocated his right shoulder and fractured his clavicle. I saw him a few days later, when it was apparent that he had neither a dislocation nor a fracture. A radiogram showed old-standing rheumatism of the shoulder-joint. Seventy days of idleness had the effect of causing him to express himself as being "worse rather than better," but it was obvious that he had recovered. When asked to move his shoulder his efforts were grotesque. I had him anæsthetized and found the joint quite movable. He was now told that if he did not go back to his ordinary work and do it, he would be reported as a malingerer and lose his pension, which in time he would be entitled to. By some mistake he was put to *light* work but would not do it. The implied sympathy of light work had a bad mental effect. He was sent to me again, and I let him clearly, definitely and finally understand that this was his last chance, and that unless he did full, laborious work, which I had arranged for him, he would be dismissed as a malingerer. He went back to work and has worked satisfactorily since.



If loss of power in the shoulder, hand or arm is alleged the following experiment is useful. The soldier is asked to take hold of a small trapeze fixed to the ceiling by a block and

tackle. He is then slowly raised a few inches off the floor and encouraged to hold on as long as he will with both hands. If he does so, he suspends his weight (probably some ten or eleven stone), and the inference is obvious.

To prove that he is really suspending half his weight by the alleged injured limb, a cross-bar may be placed loosely through the triangle of the trapeze, and whilst he supports himself by holding the ends of the loose cross-bar he is once more lifted off his feet. If he allows himself to be raised from the ground it is obvious that he must be using equal strength through each hand, otherwise the cross-bar would at once slip sideways.

J. N. joined the Army in September, 1914. He was fully trained, and in six months went to France, where he at once put himself on the sick list and was admitted into a base hospital, his complaint being diagnosed as sciatica. As soon as he ceased complaining of sciatica he developed spasmodic torticollis; he was sent back to England, treated by means of radiant heat, etc., and eventually sent to the Royal Bath Hospital at Harrogate. After some six weeks' treatment he recovered from the torticollis, but developed a spasmodic contracture of the right shoulder and muscles of the forearm; for this he was massaged and had high frequency treatment. Later he was transferred to a different hospital, where the same treatment was continued. Subsequently he was sent to London, where he was massaged by a number of ladies.

Early in December, 1915, nine months from the date on which he had first complained on being sent to France, he came under my observation as a member of the Travelling Medical Board for the London District. His right wrist was bent at right angles to the forearm; his hand was tightly clenched and held so firmly that it seemed as if the wrist were ankylosed. The case was obviously a functional one, and I suggested to the man that I should obtain his admission into a hospital and get him cured, but he at once said he did not wish to enter a hospital. Fortunately his consent was not necessary, and by arrangement with the medical officer of his unit he entered the Maida Vale Hospital for Nervous Diseases. Before doing do, he did his best to persuade the medical officer that further hospital treatment was unnecessary, stating that he was now able to straighten his arm, and that he was now applying a splint to keep it straight. I insisted, however, upon the order being carried out. In the institution at first he progressed slowly. He was told that if he recovered wholly within fourteen days I would arrange for him to be again brought before the Travelling Medical Board, when I would use my influence to have

him classified for Home Service only. Before the fourteen days had elapsed, in my presence he suspended his weight on a trapeze and pulled himself up to his chin on it, and lifted a twenty-eight pound weight with his paralysed hand. In short, he wholly recovered. He is now doing full duty with his unit.

This case is not one of deliberate malingering, but a mixture of functional disease and obvious desire to avoid active service. When he appeared before the Travelling Medical Board for a final decision of his case, I noticed that there was a tendency to assume the old paralysed position until he was sharply called to order, when his arm again assumed the normal position. That this should have happened under these circumstances, for he knew I was in possession of the facts of the case, is strong evidence of the neuropathic character of the case.

The fact, however, remains that this man, by assuming one functional nerve disease after another, prevented himself from facing the enemy, and only recovered when a bargain was made with him that he would not be required to fight and when it was brought home to him that the true nature of his case was diagnosed (for I did not scruple to tell him quite frankly that in my opinion he was an arrant coward). The direct, forcible treatment of his mental condition and an appeal to his lower instincts were immediately curative and of infinitely more value than the radiant heat, high frequency treatment, three months at Harrogate, and the application of massage.

I hope in subsequent articles to deal with fraud connected with alleged injury of the lower extremity and the back, and with various alleged neuroses.

PRELIMINARY OBSERVATIONS ON DISINFECTION OF THE NASOPHARYNX OF MENINGOCOCCUS CARRIERS BY MEANS OF AIR SATURATED WITH A SOLUTION OF DISINFECTANT.

By Lieutenant-Colonel M. H. GORDON.
Royal Army Medical Corps.

The following experiments were made for the purpose of determining whether persons carrying the meningococcus in their nasopharynx can be freed of that micro-organism by causing them to inhale the air of a room saturated with vapour containing a disinfectant.

The disinfectant used in these preliminary observations was chloramine.

For the present, attention has been confined to obtaining answers to the three following questions:—

(1) Does the air of a room when saturated with water-vapour containing chloramine exert bactericidal properties?

(2) If so, to what extent can such air be tolerated by human beings?

(3) Is the method a practical one for the purpose of destroying the meningococcus in the nasopharynx of carriers?

I. The Bactericidal Value of Chloramine Vapour.

The experiments have all been carried out in the same room, which has a capacity of approximately 1,050 cubic feet. This room was bare save for a few chairs and a table on which the spraying apparatus was placed.

In an investigation of this kind, when air is charged with disinfectant in the form of vapour, it is essential to be able to read off the amount of water-vapour present in the air at any given moment. Throughout the experiments, therefore, a dry and wet bulb thermometer was suspended from the ceiling of the room, so that the degree of humidity of the air could be observed, and any departure from the saturation point perceived at once.

Sprays Tested.

(1) *The Wassmuth Spray.*—At first a specimen of this spray, obtained by Captain Martin Flack, who has co-operated throughout in these experiments, was tried. The spray in question, however, was found to be far too small to be of use for the present purpose.

(2) *Lingner's Spray.*—An example of this apparatus was kindly lent to us by Dr. A. E. Thomas, Medical Officer of Health of Finsbury, and used in all the experiments. The Lingner spray,

originally designed for disinfecting a room with formalin vapour, consists of two essential parts. The first of these is a ring-shaped copper boiler, in form not unlike a bicycle tyre, and fixed immediately over a circular trough, which is filled with asbestos wool moistened with spirit. From the boiler, three pipes convey steam centrally to a chamber of about two litres capacity, in which the solution of disinfectant is placed. The roof of this chamber carries a safety valve and four spray nozzles which point vertically upwards. In practice, the boiler of the spray is first filled with 1,500 cubic centimetres of water and then the disinfectant chamber is charged with 1,500 cubic centimetres of solution to be tested. Owing to the powerful nature of the burner, and to the efficiency of the boiler, the sprays begin to work within about ten minutes of lighting the burner. The dry bulb temperature of the room rapidly rises, followed by that of the wet bulb. In about ten minutes after the sprays have started (i.e., twenty minutes after lighting up), the temperature of the two thermometers becomes equal, indicating that the air is saturated.

Owing to the comparatively small size of the instrument, the sprays in the Lingner apparatus cease work after running for about forty minutes. Thus the air of the room could not, with this apparatus, be kept saturated with the disinfectant vapour for over twenty minutes.

In the following experiments, therefore, the Lingner apparatus was first of all charged with enough spirit, water, and disinfectant respectively to produce a preliminary saturation of the air of the room. The apparatus was then rapidly recharged, and when the two thermometers suspended in the air of the room had for the second time become equal, the plates were exposed for the periods stated.

Mode of Determining the Bactericidal Action of the Air.

Procedure was as follows: *Staphylococcus epidermidis* was used as the test micro-organism. This staphylococcus is easily obtained by the simple expedient of rubbing a little broth on the skin of the hand, and then distributing a loopful of this skin washing over an agar slope.

A capillary pipette was charged with a series of equal volumes of a young broth culture of the skin staphylococcus, the units of broth being separated from each other in the pipette by air bubbles in the manner advocated by Wright. Each of these equal amounts of broth culture was then expelled in turn on to a separate agar plate and distributed over its surface by a sterile bent iron wire. Thus an equal amount of staphylococcus was sown on each plate.

In all the tests one of the plates inoculated with the staphylococcus in the manner described was kept as a control to show that a culture of living cocci had been employed. In all of the experiments also another of these plates was directly exposed for a moment to the spray itself, so as to determine whether or no this was immediately bactericidal. The remaining plates of the staphylococcus were exposed to the air of the room after it had become saturated with the vapour of the antiseptic. These plates were exposed to the air in one of two places, namely: (1) on the table near the spray, but not visibly sprinked by it; and (2) as far away from the spray as possible—i.e., on the ledge of a window fixed in the outer wall of the room.

Results.

The outcome of six experiments made in the way described may be summarized as follows :—

(1) The temperature at which the air of the room became saturated varied in the six experiments from 77° F. to 85° F.

(2) In all of the experiments the control plate showed a profuse confluent growth of the staphylococcus.

(3) The strength of the chloramine solutions tested varied from one to five per cent. The spray was not found capable of destroying the staphylococcus immediately when it contained less than 1·5 per cent of chloramine.

(4) When two per cent of chloramine was used in the spray, the plates, both on the table and on the window-ledge, were partially sterilized in five minutes, and completely so in ten minutes. Below this amount of chloramine, present results are contradictory, and the experiments are being repeated.

(5) As regards toleration, air saturated with moisture from a spray containing five per cent of chloramine is distinctly trying, and after two or three minutes painful. Air saturated with vapour from a spray containing two per cent of chloramine, however, is easily tolerated for at least five minutes on first acquaintance with it. Some can put up with this air for twenty minutes or longer. A promising feature of these experiments with vapour containing chloramine is that one soon becomes accustomed to it, tolerance being speedily raised.

II. Trial of Air Saturated with the Vapour of a two per cent Solution of Chloramine upon Carriers of Meningococcus.

In view of the pronounced bactericidal action which air containing chloramine vapour had thus been proved to possess for the staphylococcus, no less than by reason of its comparative

innocuousness to human beings under the conditions tested, the effect of such air was now tried upon persons carrying the meningococcus in their nasopharynx.

Case 1.—The first case was that of a clergyman who had become a carrier as the result of attending a soldier suffering from cerebrospinal fever in a military hospital. Owing to the true nature of the disease from which the soldier was suffering not having been realized until he was dead, no special precautions had been taken. This gentleman happened to call when the investigation had reached the stage just referred to, and as he was most anxious to be freed of the meningococcus, the opportunity was taken of determining the effect of the air of the chamber upon the meningococci in his nasopharynx. His nasopharynx having been swabbed, he put on a mackintosh and entered the chamber where the air was saturated with the vapour of a two per cent chloramine spray and gave a dry and wet bulb reading of 78° F. He stayed in the chamber for six minutes, with a staphylococcus plate exposed near him. After leaving the chamber his nasopharynx was very thoroughly re-swabbed.

The result was as follows: Before entering the chamber, his nasopharynx gave a profuse growth of meningococcus colonies. After leaving the chamber, his nasopharyngeal secretion gave no growth whatever of meningococcus. Only a few colonies of any kind grew, and they were colonies of streptococcus.

The agar plate sown with staphylococcus and exposed to the air of the chamber during his sojourn there showed a ninety-nine per cent reduction of this micro-organism as compared with a control plate.

Two days later the nasopharyngeal secretion of this case was re-examined and the meningococcus was found to be again present. After fifteen minutes' sojourn in the chamber, however, his nasopharyngeal secretion was found to be again free of it. After a further interval of two days, examination of the nasopharyngeal secretion failed to show the meningococcus.

Case 2.—A staff-serjeant who was also carrying the meningococcus in his nasopharynx was exposed in a similar way to the air of the chamber saturated with the vapour of a two per cent solution of chloramine.

The staff-serjeant was able to stay in the chamber for twenty minutes, and could have stayed longer had it been thought advisable. While he was in the room, four agar plates sown with staphylococcus were exposed. The first two plates were closed

and removed after ten minutes' exposure, the others remained open for the whole time that he was in the chamber.

The result of this test was as follows: Before entering the chamber the nasopharynx of the staff-serjeant yielded fairly numerous colonies of the meningococcus; but this organism was not so abundant as in Case 1. After leaving the chamber, no colonies of meningococcus could be grown from his nasopharyngeal secretion, which, however, showed a fair number of colonies of other organisms.

All four plates sown with the staphylococcus that were exposed to the air while he was in the chamber gave no growth. As two of these plates had only been exposed for ten minutes, it is clear that the staphylococcus had been destroyed within that time.

On the following day the nasopharynx of this case was re-examined and meningococcus found to be absent. The treatment however, is being continued.

Conclusions.

These preliminary observations furnish the following answers to the three questions formulated at the beginning of the paper:—

(1) The air of an ordinary room when brought to the point of saturation by means of a steam spray containing two per cent of chloramine acquires pronounced bactericidal properties for *Staphylococcus epidermidis.*

(2) Such air can be tolerated by human beings for a period varying from six to twenty minutes without marked discomfort, and without harm.

(3) The method succeeds temporarily in destroying the meningococcus in the nasopharynx of carriers. Its sphere of usefulness in this respect is being more closely investigated.

In view of the simplicity and convenience of the method and its obvious suitability for the purpose of dealing with a large number of carriers at a time, the above results are encouraging. That such a mode of treating meningococcus carriers has prospects of success may also be inferred from the statement of E. Kuster (*Deutsch. med. Wochenschr.*, September 9, 1915), that during an outbreak of cerebrospinal fever at Cologne early in 1915, meningococcus carriers were freed of that micro-organism by exposing them in an "inhalatorium" to an atmosphere impregnated with Sano's fluid, the active principle of which, like chloramine, is a compound of hypochlorous acid.

Proceedings of a Clinical Meeting in Egypt.

A MEETING of medical officers at a General Hospital was held on Wednesday, January 26, 1916. Chairman, Lieutenant-Colonel H. E. R. JAMES, C.B., R.A.M.C.

MALLEABLE IRON SPLINTS. BY COLONEL A. H. TUBBY.

When, some years ago, I was appointed on the staff of the Royal National Orthopædic Hospital, I found in use a small splint of malleable iron, and it struck me that its uses might be extended in many directions if it were made up in several sizes. At the time I received orders to join the M.E.F., I brought out some patterns which met with the approval of the D.M.S. at General Headquarters of the — Force and of the P.D.M.S., M.E.F. It was thought that this type of splint would prove useful in the emergencies of war, and in many instances for continued treatment. With the sanction of the P.D.M.S., M.E.F., and with the valued help of the D.M.S. — Force, an illustrated pamphlet was produced indicating the various methods of using the splints.

Malleable iron splints are made in all sizes, and will be found useful in most cases. They are made of flat pieces of iron, suitably tempered, and the successful use of the splint depends on the tempering. If the metal is too soft, the splint has not sufficient resistance to control muscular action; on the other hand, the metal must not be too hard or the splint will not bend or may break. The tempering is correct when the splint may be bent any number of times without breaking, and it is therefore indestructible. In order to protect the soft parts, these splints are covered with carbolized tow, and there is a washable macintosh covering,

The point about these splints is that by reason of the flexibility of the material they are easily fitted to any position. There are several ways of bending them—in the smaller sizes by means of the hands, or in the medium sizes across the knee, and in the larger sizes across the edge of a table. Alterations in the longitudinal plane are thus easily made. A change in the transverse plane is made by the hands acting on the ends in reverse direction, or it can be done by the use of two simple wrenches.

The advantages of these splints are as follows:—

(1) *Variability in Size and Outline.*—Being cut from thin sheets of iron, there is no limit in these directions.

(2) *Adaptability.*—They are adaptable to any part of the body, and the angle of the splint can be altered as required from day to day. There is no part of the trunk or limbs where this splint cannot be used.

(3) *They are Indestructible.*—Malleable iron, properly tempered, is practically incapable of wearing out. The splint can be bent any number of times and restored to its original shape without breaking.

(4) *Cleanliness.*—Being well covered with macintosh they can be kept quite smooth and clean.

(5) *Support.*—Owing to the thickness of the padding they lie smoothly and can be adjusted accurately to the outline of the limb. They give ample support, and are not likely to cause distress from pressure.

(6) *Cheapness.*—A set of one gross, in sizes from four to fifty inches, costs not more than two to three pounds, I believe.

The modes of applying the splints were then demonstrated, and illustrations were given for the case of lesions of the fingers, wrist, forearm, elbow, shoulder, head, and neck; also at the ankle, knee-joint, hip, and thigh. The method of employing the splints for various fractures was shown, which in many cases can be treated entirely by these splints, and in other cases, such as fracture of the thigh, temporarily.

Notes on Gunshot Wounds to Vessels, including Secondary Hæmorrhage. By Captain Heath.

We are not concerned with injuries of vessels in open wounds. These are fatal or receive adequate treatment in the field. Cases of injury to vessels admitted here have been suffering from wounds more or less closed. In the majority, there have been no signs of injury to vessels when the patient first came under observation. Some gradually, and others suddenly developed signs of traumatic aneurysm—i.e., diffuse swelling with expansile pulsation, diminution or loss of the distal pulse, a blowing systolic murmur over the swelling and pain in the swelling, and also referred to the periphery. A feature of these cases is the absence of suppuration, and it has been suggested that this is due to the oxygenating action of the effused blood. I think a more reasonable explanation is that a suppurating wound is generally open, and that if vessels give way the case becomes one of secondary hæmorrhage. Moreover, occasionally suppurating aneurysms are met with, as in one case in my series. In cases which develop gradually, the wound in the vessel wall is small, a protective clot forms, and subsequent hæmorrhage takes place into this clot. The aneurysm in these cases is more or less circumscribed. If the blood is poured out rapidly the aneurysm becomes diffuse. This may occur as a late development due to the giving way of the inner coat after injury to the outer coats of an artery, or a previously small circumscribed aneurysm may become large and diffuse through rupture of the clot. This often occurs as the result of straining, and commonly through the effort of defæcation.

In spite of the fact that in one case both artery and vein were wounded, we have had no cases of arteriovenous aneurysm. I imagine this is due to the fact that the arteriovenous sac is a late development, and occurs in cases which are not operated on.

Treatment.—All cases should be left as long as possible for collateral

circulation to develop. Some cases may consolidate and cure ensue, but in all our cases operation became necessary.

Indications for Operation are continuous increase in size; increase in pain; impending gangrene of the extremity, generally due to pressure of the organizing blood-clot; secondary hæmorrhages; signs of inflammation.

Type of Operation.—Empty the limb of blood by elevation, and apply a tourniquet above the aneurysm where possible. Where this is not feasible a temporary proximal ligature may be employed—e.g., at the root of the neck. In aneurysm of the iliac arteries the aorta may be compressed by a rubber band encircling the trunk. The clot is then evacuated through a suitable incision, and the artery ligatured above and below the site of injury. If the vein be also wounded it may be sutured or closed with a lateral ligature. If it be badly lacerated it must be ligatured above and below the lesion. As there is no sac, any form of Mata's reconstructive operation is not feasible. I have always ligatured with hardened catgut, and have had no trouble with recurrent hæmorrhages.

Permanent proximal ligature for the purpose of curing an aneurysm should very seldom be employed, for directly the collateral circulation becomes well established pulsation may return in the aneurysm. Moreover, it undoubtedly increases the risk of gangrene in the limb. I have used it successfully in one case of aneurysm in the pelvis due to injury of the internal iliac artery. I performed transperitoneal ligature of the internal iliac, and apparently obtained a cure.

In the "Supplementary Notes to the Memorandum on the Treatment of Injuries in War," the following passages occur under "Treatment of Wounds of the Great Vessels and Traumatic Aneurysms":—

"Though ligature at the point of injury is always desirable where possible, yet in certain cases proximal ligature of arteries must be done, and experience shows that unless other conditions, such as thrombosis of the vessels beyond the seat of injury, are present, it is as a rule successful, and does not lead to gangrene. For the treatment of wounds of the larger vessels and consequent aneurysms it is often sufficient to apply a proximal ligature and to control the bleeding from the periphery by light pressure with gauze soaked in an antiseptic if the wound be infected."

In these passages the expression "proximal ligature" is apparently used in two different senses. In the first it refers to ligature in continuity, and in the second to ligature of the proximal end of the injured artery. It would appear that, at any rate in the limbs, where it is possible to apply a proximal ligature it is also feasible to deal with the artery at the seat of injury, and in my opinion the latter procedure should always be adopted. If these methods fail there only remains amputation.

Gangrene is rare after these operations, even where both artery and vein are wounded. This is merely an expression of the fact that the collateral circulation has had time to develop. I have had only one fatal case. This was in a bad shell wound of the thigh, with a suppurating aneurysm complicated by secondary hæmorrhage. I amputated, but the patient died of toxæmia on the second day.

Secondary Hæmorrhage.—It has been suggested that this may be due to mild forms of scurvy, but I can find no evidence of this. Secondary hæmorrhage has been distressingly common, and always occurs in septic wounds which are not draining well. I regard this as an argument in favour of the flapless amputation, as I have never seen one of this class followed by secondary hæmorrhage.

One of the most frequent causes of secondary hæmorrhage is the use of drainage tubes. These are often too large, and are kept in far too long. One patient admitted here had a piece of tubing as large as a garden hose inserted across his thigh through a simple bullet wound. It had been in position for a fortnight, and had been resting on the femoral vessels. He had a severe secondary hæmorrhage directly after admission to this hospital, and eventually lost his leg from gangrene.

My practice is to replace drainage tubes as soon as possible by some soft material—e.g., rubber tissue or batiste. I have had no experience of coiled wire tubes. Other aids to the prevention of secondary hæmorrhages are the opening up of infected wounds to allow for efficient drainage and the removal of sharp fragments of bone or metal, which may press on the vessels. I make it a rule after one hæmorrhage to open up the wound thoroughly and secure the bleeding vessels. Capillary oozing must be stopped by plugging. I never employ the proximal ligature in continuity, as it seems to me impossible to determine the appropriate artery to which the ligature is to be applied. Moreover, I have seen disasters from recurrence of hæmorrhage following this practice. I have had only one case of recurrence of hæmorrhage in the case of a very septic gunshot wound of the leg, in which proper drainage was not obtained, and which I was forced to amputate later.

For bad secondary hæmorrhage in which the bleeding point cannot be secured, I think amputation is the proper treatment.

Captain S. Boyd, R.A.M.C., said that he had had seventeen cases of traumatic aneurysm under his care at —— General Hospital, sixteen of which he had operated on, the other one having died from pneumonia and pericarditis before any operation could be performed. This case was of considerable interest, as the bullet had entered at the back of the right shoulder and passed through the axilla into the chest. There was a large axillary aneurysm, and at the autopsy he found the sac was hour-glass in shape, there being a loculus of considerable size inside the thorax, communicating with the main sac by a narrow neck situated at the seat of the fracture of the third rib.

Of the sixteen cases operated on, two of them had required amputation of the leg. One of these was a leaking aneurysm of the posterior tibial artery, with extensive injuries of the foot and severe sepsis spreading up the leg. The man also had tetanus, and he considered amputation the proper treatment. The patient made a good recovery. The other case of amputation was one which he thought Captain Heath would be interested to hear about. The patient was an elderly chaplain, aged 62, on whom, before his admission to —— General Hospital, ligature of the superficial femoral artery had been performed at the apex of Scarpa's triangle for a traumatic aneurysm in the middle of Hunter's canal. Gangrene of the leg had followed this operation, and it was necessary to amputate through the thigh, after which he made a good recovery.

While agreeing with Captain Heath that, as a general rule, the wounded artery should be dealt with at the seat of injury, he thought that occasionally proximal ligature of the main trunk was the correct procedure. In the only fatal case in his series, he regretted that he had not been content with performing this operation. The case was one of an enormous diffuse traumatic aneurysm of the axilla, which reached from the clavicle two-thirds of the way down the arm. The man was greatly exhausted from loss of blood from the wound. After tying the subclavian artery, he had opened the sac and very severe hæmorrhage followed. This appeared to come not from the main vessels but from a spot far back from the axilla. No doubt a large branch had been separated from the main trunk, and displaced by the enormous amount of clot, and the bleeding was due to the very free anastomotic current. He had checked the bleeding by packing the cavity, but death occurred two hours later. He thought it would have been better to have simply tied the subclavian in this case. This would probably have checked the hæmorrhage from the wound for some days at any rate, when the man would have been in a better state for any more serious undertaking.

He agreed with Captain Heath that a tourniquet should be used whenever possible. He preferred to have it applied in the aseptic field, and before tightening it to cut down and find the main artery just above the sac. If any difficulty were met with in finding the artery in the sac after the latter was opened, it was then easy to trace it down from the spot where it had been isolated. He had also found arteriovenous communications very rare. In fact, his series only included one case of aneursymal varix of the axillary vessels. In two of his cases of traumatic aneurysm of the thigh he had found the vein also wounded, but there had been no evidence of the passage of blood from the sac into the veins.

As regards secondary hæmorrhage, he did not entirely agree with Captain Heath that proximal ligature of the main artery should never be performed. He thought there were some cases in which it was the best procedure, and had not had cause to regret doing it. In one of his cases

there was severe secondary hæmorrhage from an extensive wound of the jaw, tongue, and floor of the mouth. He tied both external carotids in this case, and the man made a very good recovery. He had seen secondary hæmorrhage two or three times from the stump of a "flapless" amputation, and in cases where local ligature of the bleeding vessel had not appeared quite satisfactory he had done proximal ligature of the main trunk as well. One other point he wished to refer to was the curious way in which septic wounds seemed to improve rapidly after ligature of the main artery for secondary hæmorrhage. He did not give any explanation, but had noticed it on several occasions.

Captain Blacker pointed out that a distinction should be made between the cases of injury to an artery, with the formation of a so-called pulsating hæmatoma, and those cases in which a more or less circumscribed traumatic aneurysm formed. When in charge of a surgical section he had had four very interesting cases of this kind under his care.

The first was that of an N.C.O. shot through the left arm, the bullet entering one inch to the left of the middle line anteriorly, and two and a half inches above the line of the elbow-joint, and emerging four inches above the internal condyle. On admission, there was a large diffuse swelling of the lower part of the arm with extreme discoloration of the skin and some œdema of the forearm. The radial pulse was present and normal. In a fortnight's time the greater part of the swelling had disappeared and a small circumscribed tumour remained situated over the line of the ulnar artery. This swelling exhibited expansile pulsation and a well-marked thrill and bruit. There was limitation of the movement of the elbow-joint. The patient was operated upon, a tourniquet applied to the upper arm, and the swelling incised. The inferior profunda branch of the brachial artery was found to open into the small cavity as well as the accompanying vein. The two openings were sewn up with fine thread, but the lower end of the artery could not be detected. The sac was then obliterated with deep sutures and the wound closed. The wound healed by first intention, and at the time of his discharge the power of movement at the elbow-joint had increased to some extent.

This appeared to be a case of arteriovenous aneurysm. The small cavity opened was well defined, and its interior lined with a clear glistening membrane, probably false sac wall covered with endothelium.

The second case was that of a man shot through both thighs and the scrotum. The bullet had been extracted before his admission to the hospital from the outer side of the right thigh. He was hit by a shrapnel bullet on June 17, and on July 13, when he came under Captain Blacker's care, there was present a well-marked pulsating swelling in the line of the femoral vessels, with its upper extremity eleven centimetres vertically below Poupart's ligament. The swelling presented well-marked expansile pulsation, and measured six by five centimetres. No thrill could be felt, but a marked bruit was present and transmitted downwards as far as the

popliteal vessel and upwards for some two inches. The pulse in the dorsalis pedis artery was good, and the colour and nutrition of the foot normal.

The patient stated that at the time he was hit there was considerable bleeding, which ceased on the application of the field dressing and did not recur.

On August 4, 1915, an operation was performed, Captain Hey Groves kindly assisting.

The common femoral artery was exposed and a ligature placed around it. The sac of the aneurysm was opened by prolonging the incision downwards, and the clot rapidly evacuated. A considerable amount of hæmorrhage occurred. Tightening the ligature on the common femoral arrested the bleeding from the upper end of the femoral artery, but considerable bleeding occurred from the lower end and from other branches opening on the posterior wall of the sac, and this was only arrested by pressure on the external iliac artery. The upper opening of the artery into the sac was closed by ligaturing the vessel intrasaccularly, and with a good deal of difficulty the lower end was also ligatured. The bleeding from the opening into the posterior wall of the sac was controlled by a ligature above and below it, and the sac was then dried out and obliterated in large part by deep suture. The femoral vein was hardly seen at all. The operation proved difficult mainly owing to the profuse bleeding from the lower cut end of the artery, which was not controlled by the ligature on the common femoral, and apparently came from the anastomotic circulation with branches of the internal iliac.

The patient made a good recovery, and the circulation through the foot was always good.

The third case was a very interesting one of a man with a gunshot wound of the right thigh. The bullet entered at a point 2½ inches below the anterior superior iliac spine on the right side, and remained lodged in the muscle of the inner side of the thigh. A fair amount of hæmorrhage occurred at the time, but was readily arrested by the field dressing. An X-ray photograph showed the bullet lying in front of the ascending ramus of the ischium with its long axis directed towards the small trochanter.

Examination showed a very well-marked thrill and bruit over the femoral vein, its point of maximum intensity being four centimetres below Poupart's ligament. The bruit could be heard in the popliteal vein, and could be traced up in the external and common iliac vein. No definite tumour could be detected at the site of the thrill and bruit, and there was no expansile pulsation. Over a triangular area, however, to the inner side of the anterior aspect of the thigh, measuring some eleven by eleven centimetres, there was a good deal of induration and pulsation, probably transmitted.

As there was some œdema over the indurated area, slight elevation of temperature and a complaint of pain in the leg and foot, it was decided

to operate, and this was done on July 28, 1915, Captain Hey Groves kindly assisting. The common iliac artery was exposed as in Astley Cooper's operation for its ligature, and a temporary ligature passed round it. An incision was then made along the adductor longus, and that muscle separated from the pectineus. This was followed by a sudden gush of liquid blood and the escape of large clots. Traction on the ligature round the common iliac arrested the bleeding which took place, and it was found to be proceeding from an opening about the size of a lead pencil in the cribriform fascia, over the saphenous opening. The femoral sheath was exposed and laid open, and a hole found on the inner side of the femoral vein. This was sewn up with fine thread, and the vein separated from the artery, thus exposing the opening in the artery. The latter was tied above and below the opening. The cavity from which the blood-clot had been evacuated was found to extend deeply down the thigh under the adductor muscles, and the bullet was extracted from its interior. The temporary ligature on the common iliac was withdrawn and the wound closed, the cavity of the hæmatoma being drained. The patient lost a good deal of blood, and intravenous infusion of saline fluid was carried out.

The cavity of the hæmatoma suppurated and required a second incision for drainage, but at the time of the patient's discharge from hospital had nearly closed. The pulse in the posterior tibial artery could be felt the day after the operation, and the nutrition and colour of the foot remained good throughout.

The exact relation of the artery to the vein was difficult to determine. They were closely bound together, and the physical signs, at any rate, suggested an arteriovenous aneurysm. The opening in the vein was sewn up in its continuity and the veins was not ligated. The patient made ultimately a good recovery, but had recovered very little power in the leg at the time he left hospital.

The fourth case was that of an N.C.O. admitted with a bullet wound at the insertion of the deltoid muscle, and another just above the right sterno-clavicular articulation. There was very marked bruising of the upper arm, the right side and the back of the chest, and a good deal of ecchymosis. On admission there was a history of severe bleeding from the upper of the two wounds, and this was plugged. A few days after admission some hæmorrhage occurred from the wound at the sterno-clavicular articulation, and it was decided to operate. With Captain Hey Groves's assistance the third part of the right subclavian artery was exposed and tied. This proved very difficult on account of the displacement upwards of the clavicle by a large extravasation of blood into the axilla and surrounding tissues; and the usual incision had to be prolonged up along the anterior border of the sternomastoid muscle. The outer end of the incision was then prolonged down over the line of the axillary artery, and a large collection of blood evacuated. Very profuse hæmorrhage

took place from the deeper part of the cavity, quite uncontrolled by the ligature on the subclavian artery. The cavity was more fully laid open, and a large vessel, probably the displaced first part of the axillary artery, found bleeding profusely. The two ends of this were picked up and tied. The bleeding now ceased, and the wound was sutured and drained.

At the time of the patient's discharge to England, there was considerable stiffness of the elbow and shoulder-joint, but no anæsthesia of the arm. In this patient, the little effect that ligating the third part of the subclavian had in arresting the bleeding was very striking.

These cases appear to illustrate the two main types which are met with—viz., the more or less circumscribed aneurysm, and the diffuse extravasation of blood or the pulsating hæmatoma.

In the circumscribed form the false sac speedily becomes covered with endothelium—indeed, in quite a few days. Captain Blacker thought the secret of successful treatment lay in intrasaccular ligature in all cases in which it was possible, and that the vessel should not be ligatured or exposed outside the sac if this could be avoided. In fact, the old operation of Annandale should be practised whenever possible. By this method the anastomotic branches and the vein were not exposed so much to possible injury, the tissues outside the sac were not damaged more than they had been, and the danger of gangrene was markedly lessened. He was surprised that no one had alluded to the work of the Japanese and Russian surgeons in these cases. They had had a large experience, and Kikuzi had recorded eighty-five cases of operation for traumatic aneurysms, with only one case of gangrene resulting. In view of the proved fact that in circumscribed cases the false sac speedily became covered with endothelium, the operation of Matas—viz., intrasaccular suture of the damaged vessel—could be practised in some of these cases as he had practised it in the first and third of those described, and it seemed to him that whenever possible intrasaccular suture of the openings of the vessels into the sac was the operation most likely to give good results.

Colonel Sir V. Horsley: I agree as to the rarity of arteriovenous aneurysm compared with traumatic aneurysm. The term "proximal ligature" is a bad one, and should be abolished, as it may mean ligature anywhere between the wound and the heart. It is terrible to think of large drainage tubes being used. They are productive of the utmost damage and harm. I tried coiled wire tubes, but gave them up as they became entangled in the tissues. The ideal is capillary drainage.

A Case of Diffuse Aneurysm in the Neck, cured by Ligature of the External Carotid and Vertebral Arteries. By Major T. S. Norris, I.M.S.

Private —, wounded in 1914, admitted into the military hospital about four weeks after the injury. The injury was caused by rifle bullet, which had entered his right cheek just below the malar bone and passed out just above the superior angle of the left scapula. Both the entrance

and exit wounds had healed, but the patient complained of severe pain in the neck and inability to move his head, and also of noises in his left ear, which he described as a continuous "buzzing." There was a marked swelling at and below the left angle of the jaw, which did not pulsate, and behind the sternomastoid a swelling, apparently continuous with the above, extending back to the middle line and from the skull half-way down the neck, which pulsated freely and in which a marked bruit was heard. The slightest movement of the head caused a severe pain, and the swelling was very tender. No wound or scar was to be seen inside the mouth, and no swelling could be made out on examination of the pharynx. Unfortunately a skiagram was not available. Compression of the common carotid did not stop the pulsation.

Operation.—The external carotid was exposed and compressed, pulsation seemed to be slightly reduced but by no means stopped. Compression of the common carotid at the same time had no effect. I then exposed the vertebral artery and tied it below the transverse process of the sixth cervical vertebra, and as this did not satisfactorily cut off the blood supply to the swelling I ligatured the external carotid. The pulsation now became faint, though still perceptible. The swelling gradually became reduced in size, and four or five weeks later when the patient left for England there was no pulsation and no bruit, and the swelling had almost disappeared. The "buzzing" and the pain in the neck were greatly relieved immediately by the operation.

I believe in this case the vertebral artery or one of its branches, and one of the branches of the external carotid, were injured by the bullet, which must have struck the patient when lying down with his face turned to the left side, as it would be in the act of firing.

Arteriovenous Aneurysm.—Sepoy, invalided for a rifle bullet wound of the knee. The bullet had struck his patella above its centre, and passed through the bone and the knee-joint without doing any serious damage, as his knee moved freely and there had been no operative interference. On examination, he had a slight swelling in the popliteal space, but not sufficient to be noticed unless careful examination was made. The veins of the leg were enlarged and a typical machinery thrill felt over the swelling. I was of opinion that it was an undoubted arteriovenous aneurysm, but did not verify this diagnosis as operation was not performed.

Some Notes on Seventy-two Cases of Gunshot Wound of the Face with Fracture of Maxillæ. By Captain R. B. Campion, R.A.M.C., S/R., M.R.C.S., L.R.C.P., L.D.S.E.

Causes.

(1) Modern small-bore rifle bullet.
(2) Shrapnel bullet of less velocity.
(3) Shell and bomb fragments.

Velocity of bullet, its angle of incidence, and density of bone are all factors to be considered.

In adjacent beds we had a big Irish policeman and a lightly built city clerk. The position and cause of wound were practically identical. The bullet glanced off the policeman's jaw, no fracture resulting, while the clerk's mandible was comminuted and he lost half of it.

Varieties.

Note.—All are compound fractures of bone, but differ from compound fractures elsewhere—sepsis is aggravated by food and saliva. The odour of twenty "jaws" in a ward is only equalled by a dysentery ward. On the other hand, the parts are very vascular and heal readily.

(1) Fracture with much bone comminution and loss of tissue.

(2) Fracture with little loss of tissue—e.g., rifle bullet-fissured or stellate fracture.

(3) Complete fracture. This is often through the weakest point of the jaw—e.g.: (*a*) canine region, (*b*) wisdom tooth region, (*c*) symphysis, (*d*) at place where the body of the jaw is occupied by a retained milk tooth and its successor, (*e*) where the jaw is weakened by recent extraction, (*f*) where alveolus is absorbed after an old extraction of teeth, (*g*) condyle.

(4) Incomplete, where alveolus and teeth only are damaged.

(5) Temporo-mandibular, joint involved, ankylosis may occur.

(6) Complicated by wounds of other parts.

Signs of Fracture (Inspection).

(*a*) Parts markedly displaced.
- (1) Swelling marked.
- (2) Salivation.
- (3) Bare bone fragments.
- (4) Occlusion of teeth altered (this is a symptom often noted by patient).
- (5) Teeth missing, misplaced or loose.
- (6) Loss of function (ask the patient to bite your finger).
- (7) Attitude of patient: mouth open, tongue protruding, dribbling of saliva.

(*b*) If there is little or no displacement of parts, more difficult.

Inspection with Palpation.

(1) Slight movement between the adjacent teeth or series of teeth.

(2) Crepitation.

(3) Loss of function less complete (I have known a soldier to be on duty one week after fracture occurred).

(4) Pain referred to point of fracture on palpation.
(5) Abnormal movement.
(6) X-ray.
Diagnosis is usually easy as signs are numerous in these cases.

Complications.

(1) *Primary.*—(*a*) Injury to other parts—tongue, eye, ear, neck. In one case in this series half of the upper jaw was destroyed, the mandible ditto; the exit wound was a hole under the right ear, 3½ inches in diameter; the pinna sloughed although apparently undamaged; posterior surface of the epiglottis could be seen through the exit wound, the external carotid pulsated vigorously in this wound and threatened hæmorrhage at any moment. (*b*) Hæmorrhage troublesome, plugging wound with adrenalin, hot douches, ligature of facial or any other offending artery.

(2) *Secondary Sepsis.*—(*a*) General conditions: septic pneumonia (inhalation); thoracic empyema; toxæmia, leading to exhaustion; septicæmia.

(*b*) Local conditions: (1) Necrosis is the rule for most cases. Each case got a swollen face every three or four weeks and sequestra came away. (2) Non-union, tooth between fragments. (3) Cicatricial contraction and adhesions. (4) Mal-union. (5) Sinuses may persist. (6) Salivary fistulæ. (7) Anæsthesia and hyperæsthesia, due to involvement of nerves in wound or scar tissue.

Prognosis.—Depends on many factors: (1) Extent of injury. (2) Resistance of patient. (3) Treatment administered. (4) Position of wound (*the nearer to symphysis menti the better the prognosis*). Wounds near the jaw angle are very fatal, although important structures are not necessarily injured; toxins seem more readily absorbed here than elsewhere.

Treatment.

Note.—Early stitches of soft parts almost all break down. Wiring the bone fragments aggravates necrosis and sepsis. Our primary duty is to overcome sepsis.

(1) Remove all dead and unsavable tissue, all very loose teeth (save as many as possible of these, they will be priceless in manipulating jaw fragments and in retaining dentures later), promote free drainage.

(2) Get patient's co-operation with toothbrush, powder, mouth-wash.

(3) Higginson's syringe, aq. ad lib. t.i.d., plus weak antiseptic solution.

℞	NaCl	
	Na bibor...	
	Na bicarb.	
	Pot. chlor. .. .. .. āā	ʒj.
	Acid carbol. pur:	ʒss.

Fiat pulv.

Sig.: One drachm of powder to one pint of water for forcibly syringing oral cavity.

Our Higginson has been invaluable, and has saved the life of many "jaws."

(4) Eusol wet dressings to external wound.

(5) Fowler position in bed to prevent inhalation of pus.

(6) Place parts in position where union can occur; four-tailed bandage, chin-boot, splints, etc.

Splints.

(1) *Hammond and Payne.*—Splints; simple, clean and very efficient.

(2) *Angle's bands*, with studs and wires, are useful, but require elaborate apparatus to make and to apply.

(3) *Intermaxillary Wiring of Teeth.*—By this method the jaw fragments are splinted and held in position by ligaturing the mandible firmly to the maxilla, as is done in the case of Payne's and Gunning's splints. A thin bronze ligature is passed round the neck of opposing teeth in incisor or premolar region, its ends are twisted together so as to grip the teeth firmly. The twisted ends are then united so as to close the jaws and make the teeth occlude normally; some four to six opposing pairs of teeth are thus ligatured, free ends of ligatures are then cut off and tucked away between teeth. Patient is fed through the space where a tooth is missing or behind condyle of jaw.

Advantages.—Simple, clean, quickly applied, little apparatus in mouth, no apparatus or tools needed to make or apply; in four or six weeks' good union has been obtained in many cases with this apparatus alone. Tomes's (metal cap to teeth), Gunning's (double Tomes's) and Hayward's splints are obsolete because difficult to cleanse mouth with them.

If much Loss of Bone.—Keep parts in normal position with teeth in correct occlusion by bar, later by dental plate, otherwise cicatricial contraction and deformity of face will result. If there is already deformity, use a "jack screw" to separate fragments of jaw and improve dental occlusion.

Threatened Ankylosis.—Where joint is involved, exercise and movement to make new joint; if this fails operation to make new joint.

Plastic Operations.—To lips, palate, only when sepsis has subsided.

Restoration of lost parts by—(*a*) artificial dentures; (*b*) moustache and beard with glasses hide much; (*c*) artificial nose and moustache attached where necessary.

Diet.

Slops (feeding cup with tube and spoon), minced chicken, minced vegetables, porridge, broth, tea, coffee, cocoa, milk, jelly, custard, bananas, rice, arrowroot, eggs and milk (beaten up), lemon squash, chocolate, cigars and cigarettes. On this diet jaw cases flourish and put on flesh although muzzled.

Colonel Tubby: Captain Campion has not said much about wiring of fragments. When I was ordered out here I was going to France to see the work done there. The one thing they decried was attempts to plate or wire the live fragments of fractured jaws, which gave rise to many troubles.

Captain Campion: We have not done any plating or wiring of jaw fragments here, but in those cases which I have seen in which this operation has been performed, necrosis and sepsis have been aggravated by the operation.

Papers were also read by Captain Heath, Lieutenant Cross and Captain Boulton.

Clinical and other Notes.

OBLITERATIVE ENDOANEURYSMORRHAPHY.

By Captain J. L. RITCHIE.
Royal Army Medical Corps.

Bugler H., 1/6 East Surrey Regiment, aged 19, was proceeding, with a comrade, from Kalabagh to Murree with regimental baggage, on October 11, 1915. They met two natives, who, on passing them, exposed rifles and fired at them, wounding Bugler H., and killing his comrade.

On admission to hospital the patient was suffering severely from shock, caused by a bullet wound from the base of the neck behind to the chin in front, and a large effusion of blood from the base of the skull above to the nipple line on the right side.

I saw the patient first on November 2. The effusion had gone down except for a large, walnut-sized, pulsating swelling opposite the cricoid cartilage, obviously a right common carotid traumatic aneurysm. Loss of sensation of the right lower lip and some pain and paresis of the right arm had disappeared. I left the patient another fortnight to see if the aneurysm showed signs of cure by palliative means, but, as it did not, I operated. A vertical incision was made—eventually extending from just above the clavicle to within an inch of the mandible—in the line of the right carotid artery. I severed the omohyoid and found the tissues matted together. The artery was readily exposed below, but only after a great deal of trouble above, the difficulty being due to the matting of the tissues here and because the normal relations were upset, the artery leaving the upper part of the sac at an angle of very nearly 45° upwards and backwards. The vein was separated all along the outer side, being very adherent above. Makin's small intestinal clamps, with rubber tubing protecting the blades, were applied, and I also placed untied catgut ligatures in case of need. The sac was opened and clot removed, leaving a typical text-book picture exposed of the opened sac with a small endothelial-lined groove, about a quarter the original canal in this case. I decided reconstruction was not possible and proceeded to obliterate. I used No. 1 catgut, soaked overnight in sterile vaseline, and an ordinary small intestinal needle—a spring-eyed needle not being procurable—and put in a continuous suture. On testing by loosening the lower clamp, a little blood escaped, so I introduced another layer of catgut sutures, going a little deeper—in some trepidation as to the inclusion of the vagus —and this proved entirely blood-tight. The sac was then obliterated ordinarily, and the wound closed, except that the untied catgut ligatures were still left in situ.

The patient vomited a good deal for thirty-six hours, due, I think, to nearly three hours of chloroform, but there were no other complications. The untied ligatures were removed on the third day. There is now (March 1, 1916) no swelling or other sign of recurrence, no disability, and the scar is not too noticeable.

As to the relative merits of ligature and aneurysmorrhaphy, in this case ligature would have been satisfactory, except for the lump left, but reconstruction might have been possible, and of course this could not be decided till the sac was opened.

In an artery with branches, recurrence of the aneurysm can only be certainly avoided by closing those opening into the sac from inside, assuming reconstruction of the canal cannot be done. The greatest difficulty experienced in this operation was finding the artery above the sac, cutting amongst important structures, in a fairly limited space, in much-matted tissues and with the anæsthetist close by. I should think the operation would not be difficult in many other sites. I was surprised at the ease of control of the blood-current with Makin's clamps.

STEAM BATH FOR USE IN A STATIONARY HOSPITAL.

By Lieutenant-Colonel J. W. H. HOUGHTON.
Royal Army Medical Corps.

The idea of utilizing steam for washing purposes at a stationary hospital was almost forced on us owing to the local difficulties in obtaining satisfactory ablution accommodation for personnel and patients. The difficulties presenting were:—

(1) Lack of means for the disposal of waste water.

(2) The absence of a piped water supply.

Both these difficulties are met by the steam vapour bath now in use.

(1) With a vapour bath the amount of waste water requiring disposal is so small as to be negligible.

(2) The amount of water required to generate the steam does not amount to more than a few pints.

The construction of the bath arrangement is simple and inexpensive.

The steam is provided by a Manlove, Alliott & Co.'s steam disinfector, and the bath chamber is formed of tarpaulins stretched over lengths of wooden scantling.

A rubber tube leads the steam from the exhaust pipe of the disinfector into the bath chamber; there the steam is distributed through a perforated zinc pipe which runs along the floor of the bathroom.

With a fifteen-pound head of steam in the disinfector, the temperature in the chamber is raised to 100° F. in five minutes. The bathers undress and enter the chamber. Steam is turned on, and

at 80° F. they begin to sweat. At 90° F. they perspire sufficiently to raise a good lather on their bodies with the soap provided. The temperature is not raised above 100° F. as a minute or two in that moist heat causes profuse sweating from all the pores and the individual is thoroughly cleansed. Still covered with a soapy lather, the bather emerges and a bucket of cold water is thrown over him. This produces a pleasant reaction and prevents further loss of body heat. He dries himself and redresses.

The time occupied by each individual in undressing, bathing and redressing is fifteen minutes.

The chamber in use here accommodates fifteen men, so that sixty men per hour can be easily passed through. This has sufficed all our local needs, but a Manlove, Alliott & Co.'s disinfector can provide steam for a chamber twice as large with a slight prolongation of the time required to raise the temperature to 100° F.

Apart from the cleansing of healthy men, cases of myalgia and skin disorders have received much benefit from the frequent use of this vapour bath. The men and officers like it, and its popularity has extended to the nursing sisters here. A thousand persons have passed through the bath up to date.

There has been no accident, such as fainting, etc.

The times of bathing and disinfection of clothing are synchronized as much as possible to economize fuel; both proceedings are carried on at the same time with the same disinfector.

A bucket of cold water is kept in the steam chamber for the use of those who get soap-suds into their eyes. A thermometer is kept in the bath and read at minute intervals, and the following orders have been issued for the bath attendant:—

(1) The bath attendant will always be present whilst the bath is in use.

(2) The bath will not be used except by two or more persons at the same time.

(3) The temperature in the bath must not exceed 100° F. = 37° C.

(4) Time for each bather will not exceed five minutes.

(5) A masseur will attend when necessary.

(6) The bath attendant will obtain from ward-masters the number of patients detailed for a bath, and arrange for their arrival at suitable times.

(7) The bath attendant will be responsible for the custody of all property in the bath-room, also for:—

(*a*) The cleanliness of the bath-room.

(*b*) The ventilation of the hot chamber.

(*c*) The turning on and off of the steam.

(8) If any bather should feel faint he will immediately be removed

from the bath, laid flat on the floor and douched with cold water, the orderly officer being sent for.

The bath chamber is formed by screening off with tarpaulins a corner of a drying room, fifteen feet long by eight feet wide and six feet high.

The walls and roof of the chamber are formed by a double layer of tarpaulins stretched tightly over four inches by two inches quartering. This double layer of tarpaulin encloses an air space which greatly helps in the conservancy of heat.

A small entrance door is closed by a flap of tarpaulin on the inside and a sheet on the outside. This arrangement retains the steam. The exit is formed by a flap of tarpaulin which opens directly on to the douche grating.

The chamber accommodates fifteen men at a time. Dressing accommodation is provided in the unused portion of the drying room.

Steam is led in a rubber tube from the exhaust pipe of the Manlove, Alliott disinfector and distributed through a perforated zinc pipe along the floor of the steam chamber. A removable wooden grating covers the floor, and a window in the outer wall provides light and ventilation.

HYPERTHYROIDISM FOLLOWING SCARLET FEVER.

By Lieutenant W. E. COOKE.
Royal Army Medical Corps.

Most text-books on medicine and pathology mention "infection" as an etiological factor in Graves's disease, and a history of an acute infection having occurred some time previous to the onset of the symptoms is not very uncommon in cases of hyperthyroidism. No instance, however, so far as can be ascertained, of hyperthyroidism occurring during the course of an acute specific fever has been recorded.

To what extent the clinical picture of the febrile state depends upon the alteration in internal secretions, which may legitimately be supposed to occur in common with the alterations in the external secretions, does not concern us for the moment, inasmuch as the recovery of function of the ductless glands is almost invariably complete as soon as the "convalescence" stage is reached.

The point is mentioned here because the hyperthyroidism in the six cases to be recorded may be due either to the persisting and increased alteration in function caused by the primary infection of scarlet fever or to an added infection occurring during convalescence. In either case there is practical importance in the recognition of this complication.

For some time it has been recognized that the most successful method of treatment in severe cases of infectious disease—e.g., measles and

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Name and Age.. ..	A. F., aged 20	J. W. R., aged 20	G. G., aged 18	J. J., aged 20	F. S., aged 21	C. S., aged 15
Date of admission ..	31.7.15	4.9.15	11.9.15	24.9.15	24.9.15	20.10.15
Date of onset of hyper-thyroidism	17.8.15	23.9.15	28.9.15	14.10.15	11.10.15	23.11.15
Thyroid gland ..	Uniformly enlarged Firm Bruit Thrill	Uniformly enlarged Firm Bruit No thrill	Uniformly enlarged Firm Bruit Thrill	Uniformly enlarged Firm Bruit No thrill	Uniformly enlarged Firm Bruit No thrill	Uniformly enlarged. Firm. Bruit. Thrill.
Circulatory System—						
Heart (size)	III 2 in. | 4½ in.	III 1½ in. | 4½ in.	III 2 in. | 4½ in.	III 2 in. | 4 in.	III 2 in. | 4½ in.	III 1½ in. | 4 in.
Tachycardia.. ..	Marked	Marked	Marked	Marked	Marked	Marked.
Pulsation in vessels of neck; increased area of visible cardiac pulsation	,,	,,	,,	,,	,,	,,
Vascular erythema..	,,	,,	,,	,,	,,	,,
Cardiac murmurs ..	Soft systolic murmur over all areas	Systolic murmur at apex	Systolic murmur at apex	No murmurs	Systolic murmur at apex	No murmurs.
Ocular Changes—						
Staring expression ..	Marked	Marked	Marked	Marked	Marked	Marked.
Ophthalmos.. ..	Distinct	Distinct	Slight	Very marked	,,	Slight.
Tremor of eyelids; Græfe's-Stellwag's signs	Present	Present	Present	Present	Present	Present.
Nervous System—						
Tremor	Fine tremor marked	Fine tremor marked	Fine tremor marked	Fine tremor marked	Fine tremor marked	Fine tremor marked.
Reflexes	Exaggerated	Exaggerated	Exaggerated	Exaggerated	Exaggerated	Exaggerated.
Organic reflexes ..	Normal	Normal	Normal	Normal	Normal	Normal.
Urine—						
Total quantity ..	Average, 80 oz.	Average, 78 oz.	Average, 78 oz.	Average, 76 oz.	Average, 80 oz.	Average, 81 oz.
Albumin	Occasional trace	Occasional trace	Occasional trace	Occasional trace	Occasional trace	Occasional trace.
Sugar	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil.*
Other Symptoms—	Tingling in limbs; sweating of hands; mental depression; muscular weakness; dyspnœa on exertion	Dyspnœa on exertion; muscular weakness; sweating of hands	Occasional mental depression; tingling in hands and feet; sweating of hands	Muscular weakness; dyspnœa on exertion; has numerous small "boils"; sweats	Mental depression; muscular weakness; loss of appetite; sweating of hands and feet	Mental depression; œdema of feet; muscular weakness; dyspnœa; sweats.

scarlet fever—or any large number of cases of sepsis caused by the same organism or group of organisms, is by the intravenous injection of serum taken from patients recovered from the respective diseases.

The results published by Koch of the treatment of scarlet fever by this method are so striking that the general adoption of the procedure is only a matter of a short time. Any contra-indication to the collection of immune serum should therefore be placed on record.

Blood.—The blood condition on December 20—that is, at a period of between two and four and a half months after the onset of symptoms of hyperthyroidism was :—

Case 1.—Total leucocytes, 8,225 per cubic millimetre.

Differential leucocyte count :—

Polymorphonuclears	Lymphocytes	Large mononuclears	Eosinophiles	Mast cells
57 per cent ..	20 per cent ..	17 per cent ..	3 per cent ..	3 per cent

Polynuclear count :—

I	II	III	IV	V
18 per cent ..	43 per cent ..	32 per cent ..	7 per cent ..	—

Case 2.—Total leucocytes, 10,920 per cubic millimetre.

Differential leucocyte count :—

Polymorphonuclears	Lymphocytes	Large mononuclears	Eosinophiles	Mast cells
48 per cent ..	45 per cent ..	6 per cent ..	1 per cent ..	—

Polynuclear count :—

I	II	III	IV	V
19 per cent ..	41 per cent ..	37 per cent ..	3 per cent ..	—

Case 3.—Total leucocytes, 9,048 per cubic millimetre.

Differential leucocyte count :—

Polymorphonuclears	Lymphocytes	Large mononuclears	Eosinophiles	Mast cells
57 per cent ..	30 per cent ..	10 per cent ..	2 per cent ..	1 per cent

Polynuclear count :—

I	II	III	IV	V
20 per cent ..	46 per cent ..	27 per cent ..	6 per cent ..	1 per cent

Case 4.—Total leucocytes, 10,608 per cubic millimetre.

Differential leucocyte count :—

Polymorphonuclears	Lymphocytes	Large mononuclears	Eosinophiles	Mast cells
59 per cent ..	26 per cent ..	11 per cent ..	3 per cent ..	1 per cent

Polynuclear count :—

I	II	III	IV	V
42 per cent ..	39 per cent ..	17 per cent ..	2 per cent ..	—

Case 5.—Total leucocytes, 8,736 per cubic millimetre.

Differential leucocyte count :—

Polymorphonuclears	Lymphocytes	Large mononuclears	Eosinophiles	Mast cells
59 per cent ..	25 per cent ..	11 per cent ..	3 per cent ..	2 per cent

Polynuclear count :—

I	II	III	IV	V
23 per cent ..	46 per cent ..	29 per cent ..	2 per cent ..	--

Case 6.—Total leucocytes, 10,296 per cubic millimetre.

Differential leucocyte count :—

Polymorphonuclears	Lymphocytes	Large mononuclears	Eosinophiles	Mast cells
51 per cent ..	37 per cent ..	10 per cent ..	1 per cent ..	1 per cent

Polynuclear count :—

I	II	III	IV	V
18 per cent ..	40 per cent ..	36 per cent ..	6 per cent ..	—

Unfortunately, circumstances prevented a blood-culture being done in any of the cases.

The points of interest in the above cases are :—

(1) All are males and all had typical attacks of mild scarlet fever.

(2) The cases occurred within a period of four months of the first case.

(3) They were all in the same ward.

The blood condition suggests a microbic infection, and the distribution of the cases suggests an infectious or contagious disease.

(5) The appearance of hyperthyroidism after scarlet fever would be a contra-indication to the collection of immune serum for the treatment of other cases.

A METHOD OF TREATING THE SLIGHTER CASES OF TRENCH FEET AND ALLIED AFFECTIONS.

By Captain V. E. NEGUS.

Royal Army Medical Corps.

Eighty cases of affections of the feet resulting from exposure to damp and cold form the subject of this paper.

The cases were not all diagnosed as trench feet, only 27 being sent under that heading, 50 of the remainder being classified as "myalgia of the feet" and 3 as "inflammation of connective tissue of feet," but there was no sharp dividing line between any of them, the diagnoses depending merely on the degree to which the complaint had advanced.

All of the men had come out of wet trenches, and were under treatment on the day following evacuation from their units ; this was naturally a great advantage in any observations made, and had a very obvious effect on the efficacy of treatment. Although it has no direct bearing on the subject of treatment, it may be noted that the stay in trenches was longer than the average period. Sixty-five wore long trench waders, and of the remainder thirteen had worn puttees. All, with three exceptions, had applied anti-frostbite grease to their feet and had put on dry socks as frequently as possible, and forty-one had carried out these measures daily, showing that complete prevention is not possible as long as men are

in wet trenches. Twenty-three had a combination of pain, swelling, heat and redness, many to a marked degree, and forty-four had similar signs with the exception of redness; none showed blistering. Fifty-four had swelling; in forty-seven the feet were hot, and in twenty-nine there was discoloration, so that there was no doubt as to the genuineness of the cases; they were, on the whole, as severe as a large number seen at Boulogne last winter, almost all of whom were sent home, and apparently were inefficient for a considerable length of time.

In no case was there hyperæsthesia; in forty there was anæsthesia, varying from that of "cotton wool of the sole" in the majority of cases to complete anæsthesia to pin-prick of the whole foot and ankle. Heat and cold sensation was lost more often than pin-prick, and less often than "cotton wool," and the three returned in the same order; in practically every case sensation was normal on discharge.

The duration under treatment was seven days on the average, twenty-seven being kept for eight days and over, and fifty-one for seven days and under. The limit fixed was ten days, and only two exceeded this, one returning to duty after eleven and one after fourteen days.

Of the eighty cases, seventy-eight went back to duty; one was evacuated with a septic abrasion of the foot and one because of blackness of the toes.

After using various methods a routine treatment was established, and sixty-four cases were treated in this way. If there was marked swelling, the foot was elevated as high as possible, with loose wool on it, and gentle massage with boric powder was commenced at once. In cases of marked pain, an ointment was applied made up of one drachm each of chloral hydrate and camphor and boracic ointment to the ounce. As soon as diminution of tenderness allowed of it, deep massage with boric powder was started for about fifteen minutes twice a day, followed on each occasion by exercises against weight.

On one foot circular movement of the foot against a weight of three pounds was employed, the weight being a sandbag attached to the foot by a padded band and a cord passing over a metal bar. The other foot was immobilized by sandbags and a small loop attached a weight to each toe; these weights were $1\frac{1}{2}$ lb., $\frac{3}{4}$ lb., $\frac{1}{2}$ lb., $\frac{1}{4}$ lb., and three ounces respectively. The foot and toes were exercised in turn for about twenty minutes in all.

In the evening "capsolin" was massaged into each foot, a rubber glove being worn in doing so, as the preparation is a strong counter-irritant; it is prepared by Parke, Davis and Co. It is necessary to dilute it with vaseline to strengths of 1 in 4, 1 in 3, and 1 in 2, and these dilutions were used on successive days until, on the fourth day, toleration was established and the pure ointment could be used.

It was found that by first cleaning the foot with a soap made up of one pound of yellow or soft soap, one pint of terebinth liniment, and one

pint of hot water the capsolin is absorbed better and works more effectively.

Serjeant W. Nelson, R.A.M.C., took notes of all the cases, and assisted in the treatment with great care and ability.

SURGICAL SCRAPS FROM A MILITARY HOSPITAL.

By C. HAMILTON WHITEFORD, M.R.C.S., L.R.C.P.
Specialist in Surgery, The Military Hospital, Devonport.

Suppurating Hæmatomata.—Among the wounded these are common, and if not thoroughly evacuated are prone to develop severe secondary hæmorrhage. After removal of the stinking clot, a most useful packing is gauze wrung out of a mixture of tincture of iodine one part and methylated spirit four parts. When the gauze, which does not adhere unduly, is removed forty-eight hours later, the walls of the cavity present a pickled appearance, do not ooze, and are free from odour other than that of the spirit. Healing by granulation follows.

Inguinal Hernia: Recurrence on Opposite Side.—Three cases came for operation on a recently developed inguinal hernia, in which a radical cure had been performed on the opposite side some months or years previously. These cases support the contention of those surgeons who consider that in inguinal hernia there is often an empty sac on the opposite side.

Direct Sliding Hernia.—There was a left inguinal hernia the size of a golf-ball. The hernia was found to be a direct one. The posterior wall of the sac consisted of sigmoid flexure. The opening in the sac was sutured, the sac and bowel were freed and reduced *en masse.*

Radical Cure: Results.—There have been a few recurrences, or rather yieldings of the scar. Surgically it is to be regretted that the exigencies of the service prevent the prolonged period of rest essential for the consolidation of the scar. In the absence of prolonged rest, it is not surprising that a recent scar, when subjected to severe strain, should occasionally stretch.

Abdomen: Phantom Tumour.—A very muscular man, while on active service, developed in the epigastrium a tense tympanitic swelling, which rose above the level of the costal margins. There were no symptoms, and purgatives failed to reduce the swelling. A phantom tumour was diagnosed. An anæsthetic was administered, and the tumour completely disappeared and reformed, though somewhat smaller, as the anæsthesia passed off.

Buttocks: Adhesion to each Other.—This patient, at the age of 3 years, was scalded on the buttocks. Commencing ½ inch above the anus was a bridge of dense scar tissue connecting the buttocks for 2½ inches,

A probe passed beneath the bridge. Skin flaps were dissected from the upper and lower surface of the bridge, on the lines of the text-book operation for webbed fingers. The scar tissue, measuring 2 by 1½ inches, was excised, and the flaps sutured in position. Portions of the flaps, which were chiefly scar tissue, necrosed, but the ultimate result was practically a restoration of the normal condition.

Shrapnel Wound of Buttocks, with Pelvic Abscess and Rectal Fistula.—The adjoining portions of both buttocks had been blown away, leaving a raw area in size six by five inches. A portion of the left side of the sacrum was missing. In the left side of the pelvis was an abscess of about eight ounces, which was overflowing through a narrow sinus which opened into the raw surface area. In the back wall of the rectum, three inches above the anus, was an opening ¾ inch in diameter. The buttock wound was constantly flooded with fæces.

First operation: The opening into the pelvis was dilated and the abscess drained by a large tube.

During the interval between the first and second operations, the hole into the rectum was temporarily closed by the following contrivance, which added greatly to the comfort of the patient. A piece of stout rubber, the size and shape of half a crown, was threaded at its centre with two strands of stout silk. This disc was rolled up and pushed into the rectum viâ the hole. The two strings were passed through ½ inch of small rubber tubing, drawn tight and tied over another piece of tubing. The disc, thus applied to the inner opening of the fistula, almost completely prevented escape of fæces.

Second operation: The opening into the rectum was closed by sutures in the long axis of the bowel. In three days the fæcal leak was as bad as ever.

Third operation: The rectum was dissected free from the mass of scar tissue in which it was embedded, and the opening sutured, transversely to the long axis of the bowel, suture in the long axis being found impracticable. No further leak occurred.

At the time of writing, two months after the last operation, the patient is walking about. The pelvic sinus has closed. Defæcation is normal. The raw area in the buttocks has nearly cicatrized, and the patient can sit with comfort. The chief operative difficulty was to dissect free, without buttonholing it, the rectum buried in scar tissue. At two of the operations, a large artery inside the pelvis, probably the internal pudic, was wounded and bled freely. The patient rendered the greatest assistance, and his stoicism was remarkable. Even when lying on his belly for many weeks at a stretch he never complained, and invariably managed to raise a smile. He deserved his recovery.

Forearm: Bone-graft on Ulna.—Two inches of the middle of the shaft of the left ulna had been blown away in a gunshot injury. The forearm

was flail. Three operations had already been performed, and the region was a mass of scar tissue.

A graft, four inches by ½ inch, was cut from the internal surface of the right tibia and used to bridge the gap in the ulna. The scarred skin which lay over the graft gave way, and the graft had ultimately to be removed, leaving the patient in *status quo ante*. The large amount of scar tissue spoiled what appeared to have, mechanically, a very fair prospect of success. Bone-grafting in the presence of scar tissue differs totally from grafting made into normal tissues, and in cases with much scarring is likely to have only a limited applicability.

Leg: Severe Shrapnel Injuries of Leg and Foot in which the Limb and its Function were Preserved by Conservative Treatment.—On admission the patient, aged 25, had many foul wounds of the right foot and leg. Three toes had compound fractures. The ankle-joint was open. The tibia and fibula were fractured at the centre of their shafts. On the calf was a pressure ulcer, five by four inches in area. The redeeming features were that the circulation was good and there was no serious nerve injury.

The patient had entirely lost his nerve—even being moved to the X-xay room produced an attack of weeping. The leg was suspended in a modified Salter cradle, with loops of bandage, one or two loops being removed at a time, thus allowing the limb to be dressed in sections. At different times seven shrapnel bullets with fragments of metal were removed from the leg and foot. At first it was a common occurrence for the dressing to last over an hour. The treatment lasted seven months. The patient can now easily walk five miles, and says his leg is almost as useful as before the injury.

This good recovery was due to the skill and time devoted to the case by the sisters (Misses Thomson and Lowe). In young healthy adults, conservative surgery is frequently possible for injuries which, in older or debilitated patients, would demand prompt amputation.

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A METHOD OF UTILIZING HORSE LITTER.

By Captain R. H. MAKGILL.

Royal Army Medical Corps.

The use of stable litter as a means of forming temporary roads in sand or other loose dry soils is probably familiar to many, yet it may interest those of your readers who have before them the problem of the effective disposal of manure if I give a brief account of a method adopted with success at Sidi Bishr Camp in Alexandria, whereby this substance was utilized in a manner to which no objection could be taken on sanitary grounds.

In several of the military camps round Alexandria the deep loose sand makes a difficulty in regard to the cleansing of the horse lines. The manure is so mixed with sand as to make it difficult to burn, and a conservancy service is hampered by the cart-wheels so sinking into the sand that it is practically impossible to bring wheeled conveyances to the manure pits. To get over this difficulty at Zaharia Camp during August and September, 1915, rough roads were constructed by digging tracks of the required width to a depth of about twelve inches, and filling these with about nine inches of manure, to which a covering of three inches of loose sand was added. The manure foundation soon packed and made it possible to bring light carts to the horse lines. There was this defect, however, that gradually the dried surface of the manure worked up through the sand covering, and formed an objectionable dust. Furthermore, the surface was too heavy for motor traffic.

On returning to Zaharia two months later I found the manure roads still in a serviceable condition, and on scraping away the loose sand a well-packed, firm smooth surface was revealed. It was obvious that, given a surface covering of a nature more binding and resistant than loose sand, a satisfactory and durable light road would result. I laid the matter before Mr. A. Armstrong, C.E., Chief Drainage Engineer to the Municipality of Alexandria, who is also attached to the local Royal Engineers staff. His wide local knowledge and quick grasp of the possibilities of such a road enabled him to select at once the material necessary for such a covering. This he found in a clay sand peculiar to parts of the Egyptian Delta, and locally known as "tinah." This sand has the property of packing when rolled or rammed while wet into a cement-like mass, and is therefore greatly valued for paths and tennis lawns.

At this time the military authorities had decided upon the extension of Sidi Bishr Camp, their chief difficulty being the heavy sand, which made traction throughout the camp area well-nigh impossible, while the cost of constructing macadamized roads throughout so large a camp was prohibitive. Fortunately Mr. Armstrong was able to demonstrate the existence of abundant "tinah" sand deposits throughout the camp area, and as there were present also large accumulations of horse manure—a result of the many months during which Sidi Bishr had been used as a horse transport camp—all the materials necessary for the proposed road were to hand. With the consent of the Commandant, Colonel Foster, and the approval of Major Longfield, C.R.E., Alexandria District, by way of experiment a short length of manure road with a crown of rammed "tinah" was laid in one part of the camp about December 17. This experiment proved successful beyond expectation, and the Chief Royal Engineer immediately authorized a much wider use of the method. The work was carried out chiefly by native labour under the supervision

of Mr. Armstrong, and by the end of March about ten miles of road had been laid.

The best results were obtained where the manure used was not too much mixed with sand, but even where a high percentage was present, the result was satisfactory provided a fair amount of vegetable fibre remained in the manure. Old dried manure acted as well as did fresh material.

The tracks were excavated to a depth of about fourteen inches and filled with ten inches of manure, which should be rolled, if possible, before the covering is added. The "tinah" sand was spread dry, then watered and rolled or rammed before it dried again. If the surface were watered several times a day, traffic greatly aided the packing of the sand, and could be permitted at once when the preliminary rolling was finished. At first, by way of binding, reeds were laid on the surface of the manure, but this was found unnecessary besides making the crown too springy, with a resulting tendency to crack.

Where the sand was of the best quality a wonderfully durable surface resulted, especially if it were regularly watered and rolled. The main road through the camp had to stand very heavy traffic, but even in the wettest weather heavy motor lorries were able to pass up and down freely. For lighter motors an excellent surface was afforded, while the marked elasticity of the road made riding and walking very pleasant. The difference between marching over a rigid macadam road and on these manure roads is so marked that the question arises whether more elasticity in all forms of roadways should not be secured.

No sanitary objection can be raised to the manure foundation, since the covering of packed sand precludes any possibility of fly breeding or dust formation.

It is, however, necessary to pay due attention to the upkeep of the road, watering and rolling it frequently and renewing the "tinah" sand covering wherever it shows a tendency to wear thin.

The cost of upkeep may be advanced as an objection, but it is counterbalanced by the extremely low cost of construction—practically the only cost being traction and labour, the latter being negligible where military fatigue parties can be secured. In the absence of a sufficient supply of horse manure, doubtless substitutes could be found, all that is necessary being a cheap fibrous material which will pack into a resilient mass. Dried peat moss probably would serve admirably. These experiments were carried out in a dry climate, and although there was a fair rainfall in Alexandria during December and January, it may be questioned whether the same success would have followed the use of the method under conditions preventing the rapid drying of the surface. Certainly during some of the heavier and more lasting rains the crown puddled up to a depth of two to three inches, and in places exposed the underlying manure. Probably in wet climates it would be advisable to use a crown

of gravel or light-road metal. At one part of the road in Sidi Bishr Camp a binding of fine limestone was added, and when this was rolled an excellent surface resulted. It is doubtful whether the system could be applied to other than a sandy or gravel subsoil. Heavy clay would probably keep the manure so wet that rapid fermentation would be set up, resulting in an early disintegration of the foundation. In such soils a manure road could have only a brief period of usefulness.

In certain of the Colonies roads in heavy soils are laid on a foundation of "fascines" made from brushwood. This is practically the same principle as the manure road, and with suitable brushwood the result is wonderfully good.

The manure road is so cheap that it is worthy of trial under any conditions. To find a use for a troublesome waste product is always satisfactory.

Reviews.

CEREBROSPINAL FEVER. By Michael Foster, M.A., M.D., and J. F. Gaskell, M.A., M.D., Captains, Royal Army Medical Corps (Territorial Force). Cambridge University Press. 1916. Pp. x and 222. Price 12s. 6d.

When cerebrospinal fever threatened to become epidemic among troops in the early part of 1915, the commands were divided into districts and arrangements were made for each district to have its own laboratory and bacteriologist for dealing with cases of this disease. A considerable portion of the Eastern area was served by the special laboratory equipped by the Medical Research Committee, with Captain John Gaskell in charge and housed in the First Eastern General Hospital at Cambridge. To this hospital also came cases from that district to be dealt with in a special ward under the care of Captain Michael Foster.

The fruit of the special experience of both these officers has been combined in the present work issued by the Cambridge University Press. After a preliminary chapter on the history of outbreaks of cerebrospinal fever, the disease is dealt with in its clinical, pathological, bacteriological, and epidemiological aspects. The symptoms and signs yielded by the various clinical types of cerebrospinal fever coming under the authors' notice are most carefully described and classified, and their relative and individual diagnostic values presented. The chapters on symptoms and diagnosis should be read by all of those who have to deal with cases of this disease, for they are throughout a considered record of actual experience. It is noteworthy that out of thirty-nine cases of cerebrospinal fever observed by the authors, the sphincters were affected at one time or another in no less than twenty-six, retention of urine occurring at quite an early stage in a considerable number of the cases. The constancy and the early appearance of Kernig's sign is noted, and it is pointed out that though stiffness of the hamstring muscles may prevent complete extension of the leg on the thigh in influenza and other febrile conditions,

the rigidity in those cases is of minor degree and readily to be distinguished from the true Kernig's sign. Rigidity of the neck, which is also of great diagnostic importance, varies considerably in degree and in the date of its appearance, but sooner or later this symptom appears, giving rise to head retraction. In fulminating cases, however, retraction may be absent. The authors lay stress on the absence of nasopharyngeal catarrh, both in the cases and in the carriers seen by them. The various forms of rash that may be observed in the course of the disease are very adequately dealt with, and are well portrayed by some clear and graphic plates in colour. The authors' advocacy of general anæsthesia for lumbar puncture is to be commended, for, as they point out, when the puncture has to be repeated day after day it imposes an entirely unnecessary strain on the fortitude of the patient without the anæsthetic, whereas with it the patient is frequently willing for the operation, and, indeed, when suffering may be eager for it. The chapter on treatment is both suggestive and useful. The enthusiasm of the authors for drainage of the subarachnoid space by lumbar puncture is all to the good. We must confess, however, to disagreement with their somewhat gloomy view as to the value of specific serum administered intrathecally. If the serum given in this way is specific—i.e., contains antibody for the meningococcus at work in the particular case—the usual effect, in our experience, is to promote materially the patient's recovery. Nor do we agree as to the dangers of intrathecal administration of serum, which the authors seem inclined to over-estimate. The cerebrospinal fluid is weak in antibody—hence the indication not only to drain off the contaminated fluid containing meningococci and their free endotoxin, but also to supply homologous antiserum in its place.

In addition to the valuable account of cerebrospinal fever in its clinical aspects, this book contains a first-rate description of the pathological anatomy of the disease, illustrated by a series of excellent plates. The intricacies of the subarachnoid space are clearly and thoroughly explained, and emphasis is laid upon the significant communication between the portion of it over the orbital plate and the lymphatics of the mucous membrane lining the superior portion of the nasal cavity and the posterior wall of the nasopharynx. As this mucous membrane is the admitted haunt of the meningococcus, the authors consider it to be far more likely that this micro-organism gains the subarachnoid space through the olfactory lymphatics than through the general blood-stream. The pathology of hydrocephalus is also dealt with in the light of the authors' clinical experience and careful post-mortem observations. The morbid histology of the central nervous system, the cytological features of the exudate, and the characters of the cerebrospinal fluid are also described in detail. We have only one suggestion to make here—viz., that the actual amount of albumen in the lumbar puncture fluid, as measured by an albuminometer such as Aufrecht's, might be added in future editions. Particularly worthy of note are two original observations—viz., that eosinophile cells may be present in the exudate, and, further, that the main location of meningococci is in the endothelial lining of the perivascular spaces around the central vessels where they pass through the subarachnoid space.

The view taken by the authors of this book in the light of the knowledge available to them of last year's outbreak is that cerebrospinal fever

being endemic in this country in the form of post-basic meningitis—a disease chiefly affecting infants under 2—became epidemic among troops in the winter of 1914-15, owing to a combination of circumstances, climatic and other, favourable to its spread. Whether this view of the origin of the epidemic is correct or not can only be determined when full epidemiological details of the outbreak are published. In a thoughtful chapter they insist on the influence not only of overcrowding, but also of a shifting population and of rapid variations of temperature rather than of mere humidity for favouring the spread of this disease by droplet inhalation. We note also the mention of kissing, but apart altogether from the antimeningococcal action of the bacteria normally present in saliva, we have still to learn that British soldiers are in the habit of saluting each other in that fashion. The authors prefer a plain bent wire swab to the covered West's swab, but many of their objections to the latter are obviated by making the patient hold the spatula on his own tongue, and phonate as directed in the memorandum which was issued to the medical officers in charge of troops. Their remarks on carriers are particularly sound; they point out that since Gram-negative cocci may be found in the posterior pharynx of thirty to forty per cent of persons in any particular series, the matter of carrier detection depends chiefly on the methods used for the differentiation of such cocci. The more completely and vigorously every possible test is made use of, the smaller the percentage of carriers becomes. When rigorous tests have been used the percentage is seldom higher than three to five per cent.

The book ends with a description of the characters of the meningococcus and of some of the most common Gram-negative cocci of the upper respiratory passages from which it has to be distinguished. The same care marks this part of the book as is evident in the preceding chapters and a special account is given of the researches made in the Cambridge laboratory on the differential value of certain sugars and on enzyme production by the meningococcus and *M. catarrhalis* respectively. The practical advantages of Vedder's starch agar are also drawn attention to. We may, perhaps, be pardoned for noticing a minor point and remarking that the value of sugars for differentiating both the meningococcus and *M. catarrhalis* from other Gram-negative cocci was pointed out first neither by von Lingelsheim nor by Dunham, whose papers on this matter appeared in 1906, but in a paper published by the *British Medica Journal* for August 26, 1905. For the rest, the report of the Committee who reported to the Medical Research Committee on the general work of the laboratories working for the War Office during the period more particularly covered by this book was not available when the authors went to press, but no doubt future additions will contain references to some of the observations there noticed, particularly those of Shearer and Colebrook.

We congratulate the authors and the Cambridge University Press alike upon this book, which is of very great value both from the practical and also from the scientific standpoint. As a contribution to medicine, it reflects high credit both on the University from which it emanated and also on the military authorities who gave the authors the opportunity and facilities for making the observations which they have combined to record so happily in this able and useful work.

SURGICAL NURSING AND TECHNIQUE. London: Baillière, Tindall & Cox. Second Edition. 1916. Pp. xvi and 229. Price 3s. 6d.

A second edition of "Surgical Nursing and Technique," by Mr. Charles P. Childe, Senior Surgeon to the Royal Portsmouth Hospital, has recently appeared and should receive a warm welcome from members of the nursing profession, for whose benefit it is mainly written; further, on account of the amount of useful information it contains, we can cordially recommend it to those medical men who are engaged in hospital work. It seems to us to fill a distinct want at the present time, when so many doctors and nurses are employed in the treatment of the wounded and are anxious to make themselves acquainted with the latest details in surgical nursing. The book is very carefully written and the duties of the ward sister before and after the operation, and of the theatre sister during the operation, are clearly set forth and the author has gone into details most thoroughly. Chapters are devoted to the selection of instruments and to operations in surgical homes and private houses.

Mr. Childe makes a point of giving the reasons for the various methods advised, and as a foundation clearly expounds the principles on which aseptic surgery rest, his idea being that intelligence and reasoning, and not reliance on a retentive memory, should be the guiding factors. The volume contains some excellent plates and concludes with some remarks on nursing in military hospitals.

THE CARE OF THE TEETH. By Arthur T. Pitts, M.R.C.S., L.R.C.P., L.D.S. London: Methuen and Co., Ltd. 1916. Pp. ix and 108. Price 1s. net.

This book should prove an interesting and valuable little treatise on dental diseases. It is written in simple and non-technical language and deserves widespread popularity amongst the intelligent section of the community.

The chapters dealing with the structure, development and growth of the teeth and their subsequent eruption are simply told, and, in illustrating the wonderful and ingenious methods by which Nature brings about these various processes, it should tend to impress upon the individual the great importance of bestowing every care upon them.

The subsequent chapters dealing with the every-day diseases of the teeth and gums and their effects upon the general health are worthy of serious consideration, for in them the writer has successfully shown, without going into details of dental treatment, how best they may be avoided.

Special stress is laid upon the *early* treatment and subsequent periodical supervision of children's teeth, and this, indeed, appears to be the whole crux of the great problem of successfully combating the alarming increase of dental caries. J. J. T.

Current Literature.

The Etiology of Weil's Disease. (By R. Mada, M.D., Ido, and others. *Journal of Experimental Medicine.* March, 1916.)—In this communication are summarized the publications on this subject which have already appeared in the Japanese literature.

In the course of investigations of that endemic disease of portions of Japan, which agrees clinically with Weil's disease, so-called, a spirochætal organism was discovered which is now believed to be the cause of the disease. This endemic disease in Japan is characterized by the following symptoms—conjunctival congestion, muscular pain, fever, jaundice, hæmorrhagic diathesis, and albuminuria.

At the end of 1914 the authors detected a spirochæta in the liver of a guinea-pig injected with the blood of a patient suffering from Weil's disease. They came to the conclusion that this spirochæta is the pathogenic cause of Weil's disease, and named it *Spirochæta ictero hæmorrhagiæ.* This discovery was announced in February, 1915.

The blood of seventeen cases of Weil's disease was injected into the peritoneum of guinea-pigs.

Thirteen positive results were obtained. The blood of all the patients in the fourth to the fifth day of the illness gave positive results, while that taken on the seventh day, in one instance was positive and in another gave a negative result.

The blood in one case on the ninth day of the illness also gave a positive result, but in no instance from the twelfth day on was a positive result obtained. Thus, in order to obtain positive results, the blood should be injected during the first three or four days of the illness—at any rate, not later than the seventh day. The infection can be transferred from an infected guinea-pig to others through many generations; the inoculation succeeds by intraperitoneal, subcutaneous or oral injection of two cubic centimetres of heart blood of the infected guinea-pig, and also with the same amount of liver emulsion. The first route is the most successful. The animals succumb in five to eight days after peritoneal injection.

Pathological Changes in Guinea-pigs.

These consist of marked general jaundice, hæmorrhages into the various parts of the body, and parenchymatous changes in the organs. The usual sites of the hæmorrhages are the lungs, the intestinal walls, retro-peritoneal tissues, and the fatty tissue of the inguinal region. The spirochæta is found in the blood of the infected guinea-pigs outside the cellular elements and in various organs and tissues. It may occasionally be seen in phagocytic cells. The liver contains the largest number of spirochætæ, then the adrenal glands and the kidneys. There are very few spirochætæ in the spleen, bone marrow and lymph glands, although they are rich in the blood.

The above remarks refer entirely to the distribution of the spirochæta in the experimental animals.

Characteristics of the Spirochæta.

S. ictero hæmorrhagiæ, like that of recurrent fever, belongs to the blood spirochætæ, and not to the tissue spirochætæ, such as are found in syphilis or yaws.

The most common length is from 6 to 9 microns, the greatest reaching 12 to 13 microns. In the liver the short forms measure 4 to 5 microns, the longest individuals average 20 microns, although one was seen measuring 25 microns.

The width is probably 0·25 micron. The ends are pointed and in most cases bent in the form of a hook.

The undulations are not as regular as *T. pallidum* and are usually composed of two or three large irregular or four or five smaller waves.

The methods employed in staining were as follows: liver and blood specimens are fixed with absolute alcohol, methyl alcohol or osmic acid and staining is done with Giemsa solution, three drops to about two cubic centimetres water, and allowed to stain for three hours. Under dark ground illumination the spirochætæ are readily found and present a characteristic beaded appearance. Fore and aft movements, besides movements of the ends to right and left, can be observed. There is also a twisting movement along the long axis.

Distribution of Spirochætæ in the Human Cases of Weil's Disease.

The spirochætæ are not numerous in the blood and can only be found on rare occasions by microscopical examination. An immune substance can be demonstrated in the blood after the thirteenth day.

In twelve cases the urine was examined with the dark field microscope within the first ten days of the illness and the spirochæta was recognized in two instances. In seven cases from the tenth to thirtieth day of illness numerous spirochætæ were found in the urinary sediment of the five patients who had given a negative result in the first ten days.

Injection of urine of patients intraperitoneally into guinea-pigs gave rise to infection in five instances, when the urine was taken between the eleventh and twentieth day of illness.

Post-mortem examinations were performed on twelve cases which died between the ninth and sixteenth days of illness.

The examination showed that while the kidneys contain the spirochætæ in the largest number, yet in every case the spirochætæ were found.

Post-mortem examination of two cases which died on or about the sixth day showed that the spirochætæ were present in the liver in very large numbers. Apparently as soon as the immune substance is formed in the blood the spirochætæ are rapidly destroyed.

The spirochætæ have been cultivated by Noguchi's method and also in deep blood agar tubes, prepared by mixing one part of rabbit's blood with two parts of ordinary nutrient agar at a temperature of 50° C. As soon as the medium is prepared and before it solidifies the inoculation is made by adding a drop of the infected blood and distributing it well in the medium by stirring the tubes. The tubes are incubated at a temperature between 22° C. and 25° C.

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Correspondence.

AMOUNT OF HYPOCHLOROUS ACID IN SOLUTION OF EUSOL.

TO THE EDITOR OF "THE JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."

SIR,—Our attention has been directed to an error in calculation which has appeared in the papers on eusol published from this department.

The amount of free hypochlorous acid in the solution of eusol made up according to our recommendations was stated to be approximately 0·5 per cent. This should read approximately ·27 per cent. As we have uniformly stated the weights of the constituents to be used in making the solution, this error does not in any way affect the validity of the results which have been recorded, but the point may have given rise to difficulty when solutions for intravenous injection were being tested by titration.

By following the directions given in our papers (viz., 12·5 grammes bleaching powder, 12·5 grammes boric acid to 1 litre of water) standard eusol is obtained of which in general—

1 c.c. = $\frac{N}{10}$ sodium arsenite solution
= ·00354 gramme chlorine
= ·00262 ,, hypochlorous acid.

Slight variations from this standard occur, depending on the percentage of "available chlorine" in the bleaching powder. With the best samples the percentage of hypochlorous acid in the solution rises to 0·3, but bleaching powder of B.P. standard (thirty per cent available chlorine) gives ·27 per cent hypochlorous acid.

We are, etc.,

J. LORRAIN SMITH.
THEODORE RETTIE.

Department of Pathology,
University of Edinburgh,
May 15, 1916.

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Original Communications.

OBSERVATIONS ON THE ACUTE PHASE OF FIVE HUNDRED CASES OF WAR NEPHRITIS.

By Temporary Captain RODOLPH G. ABERCROMBIE, M.D.
Royal Army Medical Corps.

THE purpose of this communication is to give in some detail the results of the personal observation of a series of cases of acute nephritis, occurring amongst the soldiers of the British Expeditionary Force, and treated by the writer at a base hospital in France. The description deals only with the first few weeks of the disease, for as soon as the patients had improved sufficiently to enable them to travel safely they were transferred to England.

The cases observed number 500; this large number is due to the fact that, at the instance of Sir John Rose Bradford, all the nephritis cases from a considerable area were collected in one hospital in order to facilitate their investigation.

The name "trench nephritis" is often given to the condition here discussed; this name, however, is misleading, in that many of the affected soldiers have never been in the trenches at all, and instances have occurred amongst men living in comfortable quarters at the base. The use of the name "trench nephritis" ought therefore to be discontinued, and the more general designation of "war nephritis" employed in its place.

The question as to how far the condition is to be ascribed to pre-existing renal disease will be discussed later; here it may be said that from the practical point of view the disease usually

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presents itself as an acute illness occurring amongst previously healthy soldiers, quite irrespective of any history of preceding renal disease, or of any evidence of arterial degeneration.

The disease exhibits the salient features of an acute nephritis: œdema, the passage of albuminous urine containing red blood cells and casts, febrile reaction, a raised blood-pressure and uræmic symptoms.

The cardinal symptoms of œdema, albuminuria and raised blood-pressure are present in the great majority of the cases, and it is to such cases that the whole of the following description applies, with the exception of a brief account of a small clinical group in which neither œdema nor raised blood-pressure occurs, and in which the prominent symptoms are those of an inflammation of the urinary tract from the pelvis of the kidney downwards. To this latter distinct group the name of "lower-tract cases" has been applied.

The subject has been considered under the following heads: Mode of onset; general characters and symptoms; œdema; uræmic symptoms; the character of the urine; the blood-pressure; the fundus oculi; relapse; complications; "lower-tract cases"; prognosis; diagnosis; treatment; post-mortem appearances; pathology and causation.

Mode of Onset.

The onset is usually rapid, so that in a few days it is obvious that the man is seriously ill; less frequently the onset is more gradual, several weeks elapsing before the disease has fully declared itself.

Premonitory symptoms are present in about one-half of the cases. Most commonly they show themselves in the form of cough and running from the eyes, symptoms compared by the patients to those of a severe cold; sometimes general lassitude and loss of appetite may precede the onset; more rarely there may be abdominal pain with occasional diarrhœa and vomiting. The period of duration of these premonitory symptoms varies from a few days to several weeks; they are not usually, however, sufficiently severe to prevent the man doing his duty. The *onset proper* is marked by three characteristic symptoms: Severe headache, swelling of the face, and shortness of breath. The shortness of breath may be aggravated by movement, so that the man may have to fall out if on the march, or it may arise independently of exertion, being at its worst at night when the man is lying down and trying

to sleep. In more than half of the cases both these two forms of dyspnœa are present in the same patient; of the remainder about equal numbers suffer only from breathlessness on exertion, or only from the nocturnal dyspnœa arising independently of it.

All three of the chief symptoms of the onset, namely, headache, swelling of the face and shortness of breath—are very constantly present; any one of them, however, may precede the others in order of appearance.

Pain in the back and limbs is commonly present at the onset. Somewhat less frequently there may be painful, scanty and too frequent micturition, and occasionally the man may notice that his urine is dark or blood-stained.

At the commencement of the illness the true nature of the malady must often be obscure, for patients frequently give the history that on first reporting sick they were prescribed for and returned to their duties; it thus behoves regimental medical officers to be specially on the watch for this condition, in order that the patients may be put under treatment as soon as possible.

General Characters.

The facial œdema gives many of the cases a characteristic aspect; apart from this, the patient's colour is often good, and he may even be ruddy; in the worst cases, however, a peculiar earthy or leaden pallor may be present, which is gradually replaced by a more normal hue as the patient improves. This early earthy pallor is quite different in aspect from the anæmia which occasionally shows itself in the later stages of the disease.

The tongue may exhibit nothing unusual; sometimes, however, it is large, moist, and uniformly coated with a smooth sheet of fur of a vivid canary-yellow colour; later, the yellow becomes deeper in shade. This appearance of the tongue, when present, is characteristic; it is probably to be ascribed to the fact that the tongue itself is œdematous, and thus the fur covering its surface is kept moist.

In contradistinction to what is usually seen in chronic nephritis, the skin is often moist; indeed profuse sweating, with the face bedewed with large drops of sweat, sometimes co-exists with uræmic symptoms and a high blood-pressure.

Bronchitis occurs with such frequency as to render it doubtful whether it should be considered as a complication or as one of the normal phenomena of the disease; it is not infrequently associated with laryngitis and tracheitis. The bronchitis is usually mild in

type, but may be persistent, severe, or even dangerous. It affects both the large and small bronchi and gives rise to a peculiarly irritative cough, with the expectoration of tenacious muco-purulent sputum, which is rarely blood-stained. In the more severe cases dyspnœa is present; this may be aggravated by œdema of the lungs and pleural effusion which often co-exist with the bronchitis. The dyspnœa due to definite pulmonary complications is continuous and accompanied by cyanosis, and is thus to be distinguished from the paroxysmal attacks of shortness of breath described below.

Attacks of dyspnœa frequently occur during the course of the disease quite irrespective of the presence of definite pulmonary complications; they are probably of the same nature as the shortness of breath which so constantly marks the onset.

These attacks usually take the form of nocturnal paroxysms. A man may have been lying comfortably in bed or perhaps sleeping; for no apparent reason he begins to feel short of breath and sits up; the breathing becomes deepened and quickened, while the face assumes a worried expression. Headache often comes on simultaneously, and the patient complains of sensations of distress of a greater severity than would have been expected from his appearance, for to the onlooker the dyspnœa seems to be troublesome rather than urgent or dangerous. After lasting several hours the breathlessness usually passes off, and the patient who during the paroxysm had been considerably relieved by being propped up, sinks down in his bed and falls asleep. The attack often recurs on several successive nights at about the same hour. During the attack no cyanosis is present and examination of the chest shows nothing abnormal; there is neither prolonged expiration, rhonchus nor dilatation of the heart.

The above is a description of a typical attack; sometimes, however, the shortness of breath is of milder grade and longer duration; slight dyspnœa may be continuously present for several days with occasional exacerbations. Cheyne-Stokes rhythm was noted in several cases, but did not appear to possess any special significance.

It will be noticed that two types of dyspnœa are recognized. One type is due to definite pulmonary complications, is continuous in character, and is associated with cyanosis; the other type occurs apart from pulmonary complications, is paroxysmal in character and is not associated with cyanosis. It must be stated, however, that paroxysmal attacks are frequently superadded to the dyspnœa due to bronchitis, and in such cases the cyanosis may become marked and the dyspnœa extreme.

The causation of the paroxysmal attacks is obscure. The dyspnœa of chronic nephritis has been attributed by several workers in recent years to an acidosis of the blood. Captain W. Langdon Brown (JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, July, 1915), however, records the investigation of five cases of breathlessness occurring in war nephritis, and in three of them no acidosis was present; he suggests that the symptom may be due to pleural effusion or œdema of the lungs. This explanation probably accounts for some cases of dyspnœa, but appears hardly adequate for all, for many instances of paroxysmal breathlessness occur after the subsidence of the general œdema and when no evidence of pleural effusion or of pulmonary œdema is discoverable.

As will be mentioned later, the blood-pressure in this form of nephritis is subject to great evening rises, which are often found to synchronize with attacks of dyspnœa and headache. It may be that these symptoms are actually due to the rise of blood-pressure, or possibly all three may be the result of some common cause, at present unknown.

The *headache* and *pain in the back* which so often mark the onset may persist during the course of the disease. The headache is usually frontal and occipital and is most severe at night; in two cases it was so intense as to give rise to the suspicion of meningitis. Pain in the legs may occasionally be distressing; it is felt chiefly at the back of the thighs or in the shins, and is unaccompanied by either tenderness or swelling.

The pain in the back usually has the character of an aching in the loins, sometimes felt more severely on one side than the other; it appears to be due to renal congestion and is often specially noticeable when the patient is passing large quantities of blood. Less commonly the pain in the back is associated with febrile reaction; it is then diffused and may be accompanied by pains in the limbs.

The *dysuria* which is sometimes present at the onset usually disappears rapidly when the patient is put to rest in bed. It is specially liable to occur when the urine is scanty, and takes the form of a frequent desire to pass water, the act of micturition, and particularly the latter part of it, being accompanied by painful straining. The pain is usually situated in the lower abdomen, less frequently in the penis. Rarely pain may be complained of over the situation of one or other of the ureters, but it does not shoot into the testicle or thigh. In one case, incontinence of urine was the symptom for which the patient was admitted to hospital; it

was unaccompanied by pain and was present for several days before the true nature of the disease manifested itself.

Of *gastro-intestinal symptoms*, constipation is occasionally present but usually responds readily to treatment. Diarrhœa is of rare occurrence; tenesmus occurred in two cases. Vomiting is a frequent symptom in severe cases; it occurs in three forms. At the onset, vomiting may be present for one or two days; it is then specially violent and often bilious in character. At a later stage, those cases in which the volume of urine is persistently diminished often suffer from protracted vomiting, sometimes bilious, and usually associated with severe anorexia. Lastly, vomiting is a common premonitory symptom of a uræmic convulsion.

The appetite is abolished during the early stages of the disease, but usually returns on the subsidence of the œdema.

Enlargement of the abdomen is a frequent symptom, and often suggests by its appearance the presence of ascites. Examination, however, usually shows that no shifting dulness is present, the enlargement being due partly to gaseous distension, and partly to œdema of the abdominal wall. Marked abdominal enlargement without ascites was present in thirty-five per cent of the cases, whereas in only seven per cent was ascites present, as evidenced by shifting dulness in the flanks.

The *pulse* during the acute phase of the disease is often slow, 60 to the minute being a usual rate; in the presence of febrile reaction or severe bronchitis, however, the rate may rise to 80 or 100 to the minute. At a later stage, during the debility which often accompanies convalescence, the pulse-rate is often slightly more rapid than normal, a rate of 90 to the minute being not unusual. When the blood-pressure is raised, the pulse shows the characters due to increased tension.

Febrile Reaction.

The majority of the cases are not admitted to a base hospital until several days have elapsed after the commencement of the illness; it is therefore not possible to state whether fever is invariably present at the onset or not.

A considerable proportion of the severe cases—about one-third—exhibit a rise of temperature to about 100° F. or 101° F. for one or two days after admission (Chart I): more rarely the temperature may be raised for about a week (Chart II). Recrudes-

cences are not infrequently accompanied by brief rise of temperature (Chart I). After the subsidence of the acute symptoms the temperature is nearly always sub-normal, and often shows a remarkably small diurnal variation (Chart III).

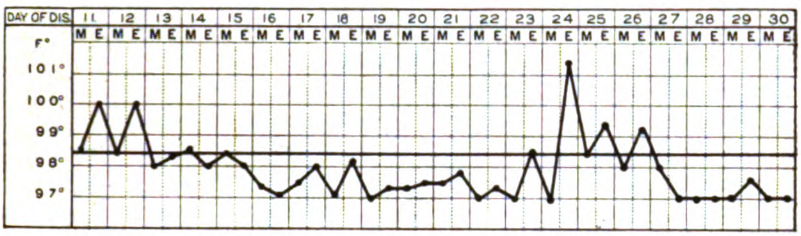

CHART I.

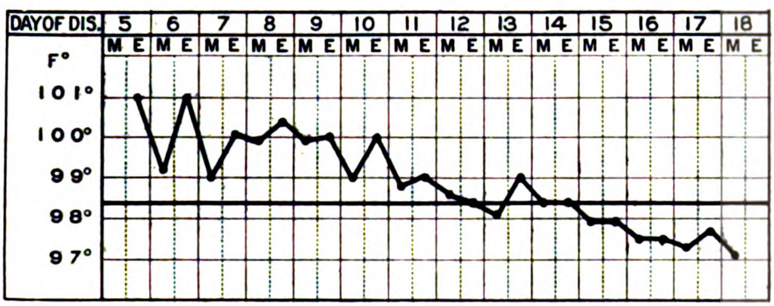

CHART II.

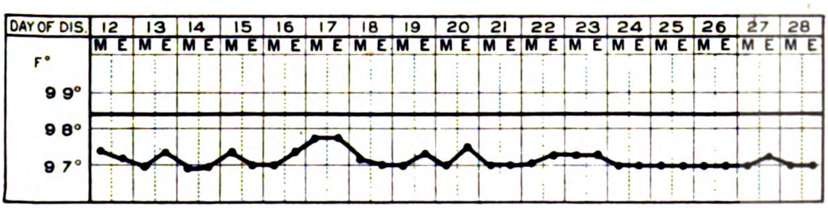

CHART III.

Occasionally pyrexia may be due to complications such as bronchitis or convulsions; but frequently, as was the case in the patients whose charts are reproduced, no such cause is discoverable. In general terms, though fever is of frequent occurrence, it is usually of short duration, and is not a prominent feature of the disease.

Œdema.

The œdema usually appears first in the face, and particularly in the neighbourhood of the eyes; it varies much in extent, from mere puffiness of the lower lids to severe general anasarca. Its distribution is that customarily seen in renal disease, the face and lumbar region being most markedly affected; exceptionally, however, it appears first in the legs and affects only the lower part of the body. The scrotum and penis are sometimes swollen, but this is rare, and is only seen in general dropsy. In one case the arms and lumbar region were alone affected.

The duration of the œdema is as variable as its extent. Rarely it may be quite transient, lasting only one or two days. The patients often give a history of œdema lasting for periods varying from a few days to several weeks prior to their admission to hospital; accepting these statements as correct, the average duration of the dropsy in fifty consecutive patients was found to be ten days. After admission to hospital the œdema usually clears up within a week.

The last relics of the disappearing œdema are to be found in the lumbar and parotid regions; sometimes a thickened condition of the subcutaneous tissue over the loins persists for a long time, so that it is not possible to pick up a fold of skin. Occasionally the conjunctivæ remain œdematous after the disappearance of the swelling elsewhere. In a few exceptional cases œdema persisted on the dorsum of the foot for several weeks after it had disappeared from the rest of the body; this was probably due to impairment of the local circulation in the feet owing to their exposure to cold and wet; in two cases actual frost-bite of the feet was present.

The œdema is occasionally obstinate, but usually responds well to general medical treatment. Out of the last 200 cases the œdema cleared up in every instance before the patient's transference to England, with the exception of two cases of the persistent swelling of the feet mentioned above.

Ascites, as evidenced by shifting dulness in the flanks, was present in seven per cent. of the cases, and was found once post mortem out of a total number of four autopsies.

Pleural effusion was present in 4 per cent of the cases and was also found once post mortem. It is usually moderate in size, and may be either unilateral or bilateral.

Aspiration was required in one case of pleural effusion; in no other case either of pleural affection, ascites or general anasarca was it necessary to remove the fluid by surgical means.

The question arises as to whether œdema is an invariable symptom of the disease. It is certainly present at some stage in the great majority of cases ; it must, however, be admitted that instances occur, although they are rare, in which other symptoms of the disease are present, yet no œdema can be found, nor any history of it obtained. The writer has seen two cases of this anomalous nature. In the first case, aged 27, the urine was of specific gravity 1,010, acid, intermittently albuminous, and contained granular casts and red blood cells ; no dyspnœa or headache ; blood-pressure 145. In the second case, aged 26, the urine was of specific gravity 1,020, alkaline, containing much albumin and numerous degenerated leucocytes, but no granular casts ; no dyspnœa, but very severe and protracted headache, with torpor ; blood-pressure 120. In neither case was there evidence or history of previous renal disease ; both cases progressed well towards recovery.

In considering such cases two possibilities must be borne in mind : in the first place the œdema may be very transient, and may therefore have escaped notice ; and, secondly, the cases may really be examples of chronic nephritis, although no evidence of long-standing disease may be discoverable. At present, the question as to the invariable occurrence of œdema must be regarded as unsettled.

In the group of cases described later as "lower tract cases," œdema does not occur.

Uræmic Symptoms.

Under this name may be grouped certain symptoms referable to the nervous system. These symptoms were formerly thought to be due to an accumulation of urea in the blood ; this view is now known to be erroneous, but the name may be still retained for purposes of convenience.

Convulsions occurred in fourteen cases, in two of which they terminated fatally. Premonitory symptoms were usually observed : these were varied in character, and in different cases took the form of severe headache, vomiting, impairment of vision, strangeness of manner, torpor, muscular twitchings, oscillatory movements of the eyes, and turning of the head and eyes to one side. Such symptoms were often present for several hours before the fit.

The convulsions were usually multiple, several fits following each other at varying intervals. The fit was often ushered in by turning of the head and eyes to one side and irregular ocular

movements; the twitchings first affected the muscles of the face, and subsequently spread to the whole body in the form of a violent epileptiform convulsion during which unconsciousness was complete; the tongue was often bitten, and the sphincters relaxed. The fit usually lasted several minutes; on two occasions, upon neither of which the writer was present, it was stated to have lasted over a quarter of an hour. The fits were followed by stupor, usually brief; sometimes the patient lapsed for several hours into a heavy, stuperose sleep from which it was just possible to rouse him by shouting.

In three cases the stupor was succeeded by an attack of *mania*, during which loud shouting and violent struggling occurred, so that it was necessary to tie the patient down in bed; after a period of about twenty-four hours the patient slept and the mania subsided, although the mind was obscured for several days longer. In one case convulsions, stupor and mania succeeded one another for forty hours, the patient ultimately recovering. In another case the patient, though not actually maniacal, got out of bed and attempted to jump out of the window. The fits may be followed by severe headache, especially if lumbar puncture has not been performed by way of treatment; and the temperature may be raised for one or two days.

The *causation of the fits* is obscure; they may occur in patients whose bowels are acting freely, whose skin is moist with perspiration and who are passing plenty of urine. In no case was an uræmic odour noticed in the breath; it must be mentioned, however, that the writer is not personally acute in detecting this manifestation. On the other hand, the patients with marked and persistent reduction in the volume of urine showed no tendency to severe symptoms referable to the nervous system, although they suffered from headache and vomiting. In every case in which fits occurred albumin was found in the urine, but sometimes only in small quantities; œdema was also present in every instance, but was sometimes only slight in grade. In every case the blood-pressure was found to be raised, but to a variable extent; in some cases it reached 200 mm. Hg; in others it was considerably lower; in one severe case the systolic pressure taken a few hours before the convulsion was only 135. Immediately after the convulsions the blood-pressure may be very high, probably as the result of the severe muscular exertion.

The pressure of the cerebrospinal fluid taken in one case immediately after the convulsion was found to be somewhat raised,

namely, to twenty centimetres; an ounce of the fluid was withdrawn, but two subsequent fits occurred within a few hours; therefore increased cerebrospinal pressure can hardly be the causative factor. The fits do not seem to be due to an accumulation of urea in the blood. In one case, the blood withdrawn immediately after the convulsion was found by Captain C. G. L. Wolf to contain about twice the normal quantity of protein-free nitrogen; but in other cases which showed no signs of fits the quantity found was much greater than this; for example, in a case of persistent reduction in the volume of urine the quantity reached five times the normal. It was noticeable, however, that the patient who had suffered from convulsions showed a higher proportion of "rest-nitrogen" (protein-free nitrogenous substances other than urea), relatively to the urea, than was the case in the other patients examined. This question is undergoing further investigation.

A remarkable feature with regard to the convulsions is the fact that after they had subsided rapid improvement in all the symptoms frequently took place, so that after a few days the œdema disappeared and the blood-pressure fell to normal; several days later the albumin became reduced to a trace or even cleared up altogether. Thus the patients who had suffered from convulsions often approached convalescence more rapidly than the usual type of case. Possibly in these cases the disease is of a specially acute type, tending to terminate, as it were, by crisis; or perhaps, the violent muscular exertion and the subsequent diaphoresis may aid in the elimination of some toxic substance; a third possibility is that the treatment used for the convulsions, such as venesection and lumbar puncture, may favourably influence the course of the disease. This last view, however, is discounted by the fact that a patient who had suffered from convulsions before he was admitted to hospital convalesced very rapidly, although no special treatment had apparently been employed.

Of other uræmic symptoms *amaurosis* occurred in three cases. In one case it was not accompanied by convulsions; in one case it preceded and in another it followed a fit. In all three cases vision returned in about twenty-four hours. *Muscular twitchings* apart from convulsions occurred in four cases.

Cases occasionally occur in which the patients are dull and lethargic in manner; they may lie in bed for several days, hardly speaking or appearing to notice their surroundings.

Headache, dyspnœa and vomiting, which should perhaps be classed with the uræmic phenomena, have already been alluded to.

The Urine.

Early in the disease *the volume of urine* passed is usually diminished; in severe cases actual suppression for twelve hours or more may occur, but this is an unusual event. Usually the patient passes twenty or thirty ounces during the first twenty-four hours in hospital; the quantity increases day by day, so that after a few days' treatment the volume reaches the normal; later from sixty to eighty ounces, or more, are passed daily. This latter result is probably due to the drinking by the patient of large quantities of fluid. Considerable variations in the volume from day to day are not infrequently seen. Only exceptionally is the quantity of urine persistently diminished in spite of treatment.

The amount of *albumin* present varies from a trace to ten grammes per litre (one per cent) as estimated by Esbach's method; a usual quantity during the early days of the disease is between two and five grammes per litre. The amount may be subject to wide diurnal variations, the urine passed first thing in the morning containing more than that passed in the evening; indeed the morning estimation may show a quantity twice or three times greater than that present at the evening estimation.

As the patient approaches convalescence the percentage quantity of albumin present in the morning urine tends to remain fairly constant from day to day, and is but little affected by variations in the total volume of urine passed in the twenty-four hours.

Exceptionally, and especially during the final phase of the disease, the albuminuria may be intermittent; it may be absent for several days and may then reappear, either spontaneously or as the result of getting the patient up and putting him on full diet. This fact is of importance from the point of view of diagnosis, as indicating the necessity for repeated examinations in certain cases.

The albuminuria usually gradually diminishes under treatment, but is often very persistent. Many cases occur in which the other symptoms subside and the patient feels quite well, but still continues to pass a large amount of albumin.

In a small minority of cases the albumin completely clears up within a few weeks; since, however, the majority of the cases were sent home with albuminuria still present it is not possible to state its usual duration.

Hæmaturia is a frequent symptom, the amount of blood passed being often great. Occasionally hæmaturia of considerable amount persists when the patient is otherwise free from symptoms, the

amount of albumin in the urine apparently corresponding to the quantity of blood; this persistent hæmaturia appears to be in no way dependent upon increased blood-pressure. Even in the absence of obvious hæmaturia red blood cells can be found microscopically in the majority of cases. In no instance were blood-clots present.

The *reaction*, if the urine be examined shortly after it is passed, is almost invariably acid; very rarely it may be amphoteric.

During the acute stage of the disease the *specific gravity* of the urine is usually about 1,020 or 1,024; at a later stage, when the patient is passing a large quantity of urine, it usually falls to about 1,012 or 1,010. During the early phase the *colour* is often smoky or blood-stained, more frequently hazy; later the colour is usually normal, or may sometimes become pale

A *deposit* of mucus is usually present, and is often blood-stained; rarely it may be brownish from the presence of urates. Blood-cells, casts, epithelial cells and degenerated leucocytes may form part of the sediment; but in none of the cases was a deposit of obvious pus observed.

Microscopic Characters of the Urine.—Granular casts are practically invariably present at some stage of the disease; hyaline casts are found somewhat less frequently, still less frequently blood casts. In two cases waxy casts were present; these were large, fissured, and often presented a peculiar segmented or caterpillar-like appearance. In one of these two cases the patient was found post mortem to be suffering from an acute attack supervening upon a preceding parenchymatous nephritis; and in the other case the pallor and the history of preceding ill-health rendered it probable that the patient was suffering from a similar condition. In two other cases casts were found which resembled waxy casts, although they were not quite characteristic; both cases showed a tendency to lapse into chronicity.

Red and white blood cells and epithelial cells from different parts of the urinary tract are often observed. Degenerating leucocytes may be present in large numbers.

The Blood-pressure.

The blood-pressure appears to be always raised at some stage of the disease, giving rise to an accentuation of the aortic second sound and an increased tension of the pulse.

The duration of the elevation of pressure is variable; in cases

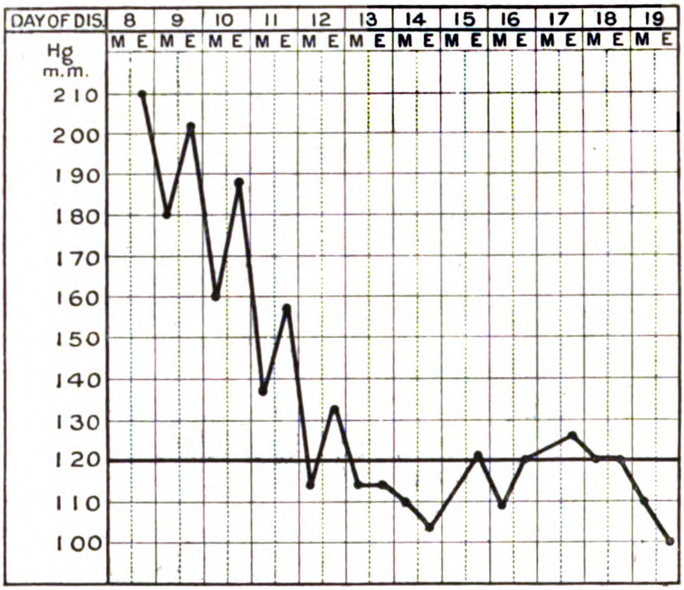

CHART IV.—Systolic pressure taken twice daily, at 10 a.m. and 6 p.m., and recorded in mm. Hg. "Staircase" descent.

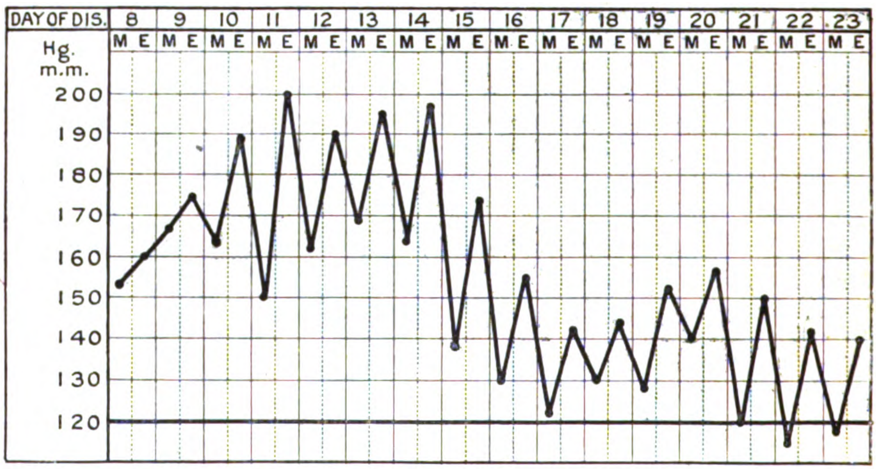

CHART V.—Systolic pressure taken twice daily, at 10 a.m. and 6 p.m., and recorded in mm. Hg.

of moderate severity the systolic pressure is usually raised for a period of from five to ten days after the patient's admission to hospital; in more protracted cases the elevation persists for several weeks, so that the patients are transferred to England with the blood-pressure still high.

During the acute phase of the disease the systolic pressure usually ranges between 135 and 180 mm. Hg; exceptionally and especially in association with convulsions, it may reach 200. It will be noticed that the pressure is not so high as that usually seen in chronic renal disease; indeed a pressure of over 200 is presumptive evidence that the malady is of long standing.

If the pressure is observed twice a day a wide diurnal variation is often noticed between the morning and evening pressure, the evening pressure being nearly always the higher; indeed, there may be a difference of 20, 30, or even 60 mm. Hg between the morning and evening records (Charts IV and V.)

Charts IV, V, VI and VII give records of the systolic pressure taken twice a day, namely at 10 a.m and 6 p.m., and recorded in mm. Hg.

When the pressure is falling from day to day it usually does so in a series of morning remissions and evening rises, thus forming a descending "staircase" (Chart IV). Exceptionally when the pressure is falling unusually rapidly the evening pressure may be lower than that recorded on the preceding morning; in such cases the chart may be compared to the temperature chart of a case of pneumonia terminating by crisis. (Chart VI.)

The chart may present the following characters: During the first part of the acute phase, the pressure is irregular; when the acute symptoms begin to subside, a stage is entered of large diurnal variations, with evening rises and morning falls; subsequently the records may be subnormal, rising later to the normal or slightly above it. (Chart VII.)

In the majority of the cases the amount of albumin diminishes *pari passu* with the fall in the blood-pressure; sometimes, however, the blood-pressure remains high while the albumin diminishes; sometimes the blood-pressure falls while the albumin remains abundant; and rarely one curve may rise while the other falls.

The blood-pressure record is often of great value in judging of the progress of a case. The writer can confirm Captain W. Langdon Brown's observation, that those cases appear to do best in which the pressure is at first high and subsequently rapidly falls to the normal. The pressures were recorded by means of a tambour sphygmomanometer (Tycos) with the patient recumbent.

The question as to the relationship between the evening rises of blood-pressure and the nocturnal dyspnœa and headache has already been discussed.

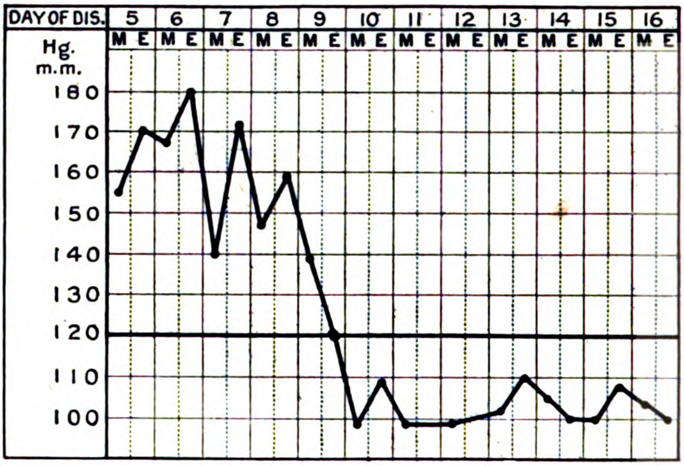

CHART VI.—Systolic pressure taken twice daily, at 10 a.m. and 6 p.m., and recorded in mm. Hg. Termination by crisis.

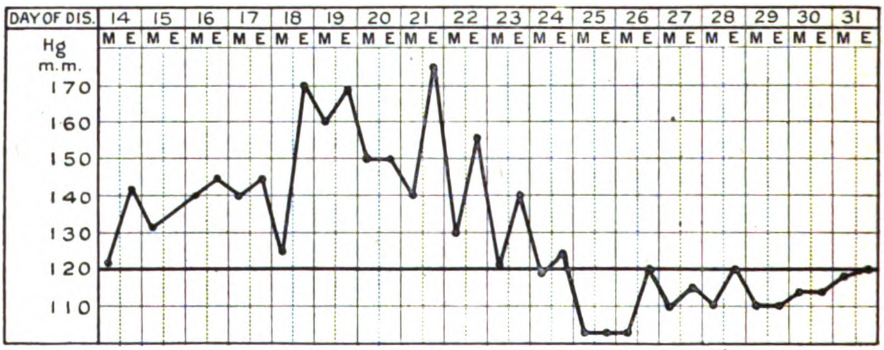

CHART VII.—Systolic pressure taken twice daily, at 10 a.m. and 6 p.m., and recorded in mm. Hg.

THE FUNDUS OCULI.

Major Gunn, C.A.M.C., examined the fundus oculi in fifty consecutive cases, the majority of which were in the first few weeks of the disease, none having complained of symptoms for a period longer than six weeks. In forty-nine of these cases no fundal

changes were observed, with the exception of a slight haziness of the disc, of doubtful pathological significance, noted in three cases. In one case well-marked retinitis was present; the patient was in civil life a painter; his radial arteries at the wrist were much thickened and the blood-pressure was over 200; so that there is little doubt but that in this case the fundal changes were to be ascribed to a nephritic condition of long standing.

Colonel Lister and Major Cunningham also examined a considerable number of the cases; in every instance the fundus was normal, with the exception of one case in which retinitis and a flame-shaped hæmorrhage were present; in this case also the changes were probably of long standing, for the patient gave a definite history of preceding renal disease.

At a somewhat later date, namely, from the seventh to the ninth week from the first onset of symptoms, retinal changes have been found in patients subsequent to their transference to England (Moore, *Lancet*, December 18, 1915). From these facts it would appear that retinal changes are unlikely to occur in the early stages of the disease, but may commence to show themselves during the second month.

Relapse.

Recrudescences of the hæmaturia and temporary aggravations of the albuminuria are of frequent occurrence; they are often associated with pain in the back and headache, less commonly with diminution in the volume of urine and transient elevation of temperature. Even more frequent are sudden returns to a heightened blood-pressure. These aggravations in the symptoms are specially liable to follow exposure to cold; sometimes they appear to be due to an increase in the diet; very often, however, no cause for them can be discovered.

Only very exceptionally are these recrudescences accompanied by a return of the œdema. True relapse, in the sense of a repetition of the characteristic features of the original attack, including œdema, occurred only in about two per cent of all the cases; and in no case was the recrudescence or relapse accompanied by severe uræmic symptoms.

Complications.

Several complications have already been described, of which the most important are: bronchitis, tracheitis, laryngitis, suppression, vomiting, diarrhœa, ascites, pleural effusion, convulsions, mania, amaurosis.

Epistaxis occasionally occurs; it is not usually a serious symptom. Rarely, however, it is associated with hæmorrhage from the gums and other mucous surfaces, and it is then of grave import. In a few cases blood-streaked vomiting and melæna occurred.

Tonsillitis, so far as the writer's observations go, is very rarely present; the pain on swallowing sometimes complained of is usually to be ascribed to tracheitis or laryngitis.

Sudaminal eruptions are not uncommon; extensive erythema, followed by desquamation, occurred twice; in neither case did the distribution or course of the eruption resemble that of scarlet fever.

Anæmia occasionally supervenes about the third week of the disease. The transient leaden pallor sometimes seen at the onset has already been mentioned.

Thrombosis of the left femoral vein occurred in one case.

A *systolic murmur*, heard best at the apex or to the left of the sternum, was present in seven per cent of the cases. In a few of the cases the murmur may have been due to anæmia; in several, cardiac hypertrophy or arterial degeneration were present; and in a very small number there was evidence of dilatation of the heart. In the great majority of the cases the significance of the murmur was doubtful. The murmur in some cases may be due to the effect upon the heart of the suddenly raised blood-pressure, although definite dilatation of the heart may not be demonstrable; this view is supported by the fact that in several instances, as the patient improved, the murmur disappeared. During the debility which accompanies convalescence the pulse-rate is not infrequently quickened; this would appear to indicate that during the acute phase of the disease some agency had been at work causing weakening of the heart-muscle. The question as to whether active endocarditis sometimes occurs cannot be decided until complete information as to the after-history of the cases is available.

Two complications, namely, *herpes* and *parotitis*, are of special interest in that they point to an infective origin of the disease. Labial herpes was observed six times amongst the last 200 cases; parotitis occurred four times in the whole series. The parotitis was bilateral in three cases, unilateral in one; it was painful, indolent, and subsided without suppuration.

A large number of the patients were found to be the subjects of septic inflammation in such forms as boils, impetigo, acne, styes, sores about the hands, and alveolar abscesses. In one case, œdema

and other symptoms of nephritis were found to co-exist with cerebrospinal meningitis.

Cases showing Symptoms of Inflammation of the Lower Urinary Tract.

These "lower-tract" cases constitute about five per cent of the total number, and form a clinical group which is distinguished from the true nephritic cases by the absence of œdema and of raised blood-pressure, and by the greater prominence of symptoms which appear to indicate an inflammation of the lower urinary tract from the pelvis of the kidney downwards.

The true nephritic cases sometimes suffer from aching in the loins and dysuria; but in the "lower-tract" cases these symptoms are much more marked. In the latter cases the lumbar pain is usually localized to one side, commonly the left, and may be so

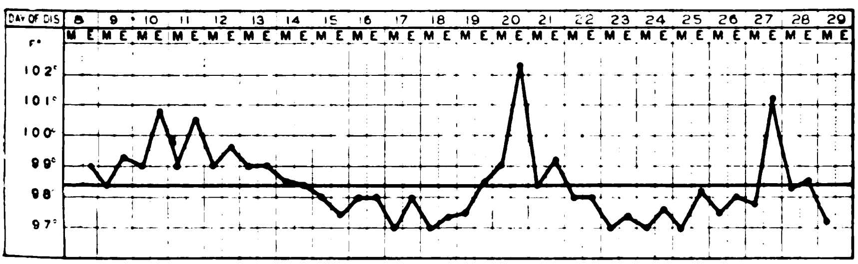

Chart VIII.—"Lower tract" case with two relapses.

protracted and severe as to give rise to the suspicion of renal stone; the symptoms of bladder irritability are also specially severe, and in several cases the pain was referred to the perineum and rectum, suggesting involvement of the prostate. The cases are also often characterized by a considerable grade of pyrexia; whereas in the true nephritic cases a temperature of 102° is rare, in the "lower-tract" cases it is common; indeed, a remittent temperature of 103° or higher may be present for a week or more. A further feature is the passage of exceptionally large quantities of blood in the urine; and there is a special tendency to relapse, each relapse being accompanied by a rise in the temperature and a return of the hæmaturia (Chart VIII). Œdema is absent, and the blood-pressure is normal or sub-normal. The patients suffer from headache, but definite uræmic symptoms do not occur.

The urine is usually acid, rarely amphoteric or alkaline; it contains epithelial cells from different parts of the urinary tract and large numbers of degenerated leucocytes, which persist after the disappearance of the blood. It is noteworthy that considerable numbers of granular casts are also not infrequently present. In none of the cases was there a deposit of obvious pus.

The relationship of these cases to the true nephritic cases is ambiguous. Probably both types of case are different phases of the same pathological process, which may be supposed to affect with greater severity sometimes the upper part of the urinary tract, and sometimes the lower part. This view is based on the fact that both classes of case occur at the same time, that herpes is seen occasionally in both, and that several nephritic cases have in their later stages developed "lower-tract" symptoms.

Prognosis.

The immediate prognosis is good. Out of five hundred cases, four terminated fatally, and of these three were found post mortem to have suffered from an acute attack superadded upon long-standing renal disease.

Two of the fatal cases died as the result of convulsions, and two from repeated hæmorrhages and exhaustion.

The remote prognosis is more doubtful. As has been mentioned, the œdema nearly always cleared up under treatment; the albuminuria, on the other hand, is more persistent, so that the majority of the patients when transferred to England were still passing a considerable amount of albumin.

At present it is not possible to derive definite prognostic indications from the course of the disease: it has appeared to the writer, however, that the cases in which both œdema and albuminuria cleared up rapidly were likely to do well, and that a high blood-pressure followed by a rapid fall was a favourable sign. Unfavourable cases were those with persistent œdema, those in which ascites occurred, and those in which anæmia appeared. Difficult cases to make a prognosis were those in which all the symptoms cleared up and the patient felt well, but yet continued to pass large quantities of albumin or even blood.

The work of the Medical Research Committee, in obtaining a continued record of the cases, will be of great value in forming conclusions as to the prognosis; from this and other sources the writer has learnt that many of his cases have suffered from debility or albuminuria for periods measured in months from the time of

their arrival in England, and that a few cases have terminated fatally after a prolonged illness.

Diagnosis.

The disease in its early stages is often missed, its symptoms being for a time mistaken for those of various minor ailments. The hæmaturia and pain in the loin have in some cases led to the diagnosis of renal calculus.

On the other hand, albuminuria occurring as the result of various febrile conditions is sometimes mistaken for nephritis, as are also facial erysipelas and urticaria; the discrimination is not usually difficult, especially if means are at hand for the exact estimation of the blood-pressure. Functional albuminuria is to be distinguished by the absence of all other signs of disease.

Exacerbations of long-standing renal disease are characterized by the presence of cardio-vascular changes, and in some cases by the history.

The chief practical difficulty in diagnosis arises in the case of men who have been sent down the line as suffering from nephritis, but who, by the time they reach the base, have lost all symptoms of the disease, except, perhaps, a trace of albumin in the urine. Since the diagnosis made at the Front is often necessarily of a provisional nature, it is important to decide whether these patients have really had nephritis or not, for if they have they ought not to be sent back to the trenches until after a period of rest in England. In such cases the exact estimation of the blood-pressure is often of great value. Sometimes it may be advisable to put the man on full diet and let him help in the ward work, the urine being examined for several days in succession; the return of a cloud of albumin with granular casts or a considerable rise in the blood-pressure not infrequently establishes the diagnosis.

One patient was admitted unconscious after a fit; no œdema of the face was present, and the diagnosis was at first obscure; a blood-pressure of 210 and the discovery of a lumbar pad of œdema cleared up the nature of the case.

The points of distinction between the "lower tract" cases and the true nephritic cases have already been mentioned. In the former type of case the marked pyrexia may lead to a suspicion of typhoid fever.

Treatment.

Warmth in bed, the drinking of diluent fluids, and the administration of saline purgatives, were the essentials of the treatment

employed during the acute phase of the disease. Warmth is highly important; to ensure it, the patients should be nursed between blankets and adequately covered up; it has several times been observed that severe cases did not improve until they had been transferred from a cold ward to a warm one. Anything like open-air treatment has been proved to be quite out of place in the treatment of these patients. The value of warmth is probably due to its effect in determining blood to the surface of the body with the consequent relief of renal congestion, and to the promotion of the excretory function of the skin.

With regard to diluents, the patients were given daily four pints of milk, two and a half pints of barley water, and a pint and a half of lemonade, eight pints of fluid in all. The drinks were all given warm, and were administered every two or three hours. The objects aimed at by this excess of fluids were the restoration of the urinary flow, the rendering of the urine less irritating by dilution, the washing of toxins and inflammatory products from the kidneys, and the promotion of perspiration.

With regard to purgatives, the patients were given a dose of castor oil on admission, if constipation had been previously present; the bowels were subsequently kept open once or twice daily by the use of a daily morning purge of magnesium sulphate, the usual dose being half an ounce.

Under this simple treatment the acute symptoms usually subsided rapidly; patients admitted after a week or ten days' illness in a state of great distress often passed within two or three days to a condition of comfort; the urinary flow was re-established, the blood-pressure fell rapidly, the amount of albumin diminished and the œdema began to subside.

The question of *diet* is a difficult and important one, and one upon which considerable difference of opinion exists. Some observers restrict their patients to fluids for a considerable period, others allow solid food from the start. The writer does not wish to be dogmatic on this point; his personal opinion is, however, that during the early part of the illness the patients do best on the fluid diet described above, an orange or other fruit being perhaps given as a placebo. At a later stage, when the œdema had been absent for several days, the blood-pressure was approaching the normal, and the albumin considerably reduced, the patients were given bread (three-quarters of a pound), butter, and rice-milk (one pint), with milk (three pints), barley water and lemonade in addition. The period for which patients were restricted to fluids was usually about ten days.

The fluid or solid character of the diet appeared of more importance than its chemical composition; the effect of the addition of solid food should therefore be watched; not infrequently it is followed by a slight rise of blood-pressure, occasionally by an increase in the albumin, more rarely by a return of pain in the back and of blood in the urine. If these disturbances are severe, the patient should be put back on fluids.

The diet must, of course, be modified by a consideration for the individual patient, the tongue, appetite, and general condition being taken into account. Anasarca is not as a rule a contra-indication to excess fluids; but if there is a tendency to persistent waterlogging the fluids should be reduced: again, if the fluids promote vomiting, solids should be substituted. In such cases a diet of weak tea and toast is sometimes useful for a few days. When the gastric disturbance is severe it may be well to substitute barley-water for milk for one or two days. In general terms it may be said that though the excess of fluid is not always tolerated, yet those patients do best who are able to take it.

The fluid diet does not seem in any way injurious to the patients; on the contrary, patients admitted to hospital looking pallid and ill often became ruddy and healthy-looking on a diet of milk only; in such cases the pallor was clearly not due to the fluid diet, but to the disease.

As convalescence commences, pudding, eggs, and occasionally fish, were added to the diet, their effect being watched; the final stages of convalescence did not come under the writer's observation.

Since the causation of the *uræmic convulsions* is unknown, their treatment is empirical. Lumbar puncture under chloroform appeared to be of real value, about one ounce of fluid being withdrawn; in only one case did fits recur after its use. Venesection (twenty ounces being withdrawn) also appeared useful, especially if followed by saline transfusion into the vein. Morphia (quarter grain hypodermically) was employed with some apprehension, and was only used twice; in one case the fits recurred, in another they ceased. The use of hot packs as treatment for this complication was abandoned; in three cases they appeared to do actual harm, the patient having a fit soon after the application of the pack; the heat to the skin appeared to act as a stimulus. Since the patient often perspires freely, there is no clear indication for their use.

The troublesome *bronchitis* was much benefited by a mixture containing tr. camph. co., liq. ammon. acet., and small doses of vin. ipecac.

Dyspnœic patients should be propped up in bed, the upper part of the body being kept warm by a nursing-cape.

Full doses of bromide were used for *severe headache, restlessness,* and *nocturnal dyspnœa.* Where definite *cystitis* was present, it was treated by means of pot. citrate, and tr. hyoscyamus. When *anæmia* supervened, iron was useful.

Pleural effusion usually disappears rapidly; if large or obstinate, however, it ought to be tapped, for it must increase the danger should convulsions supervene.

There are no grounds for the administration of urinary antiseptics, for the urine is nearly always sterile, and organisms cannot be found in the kidneys examined post-mortem; nor does any indication exist for the use of diaphoretics or diuretics as a routine treatment; such remedies may well increase renal congestion, and thus do harm.

The patients should be kept strictly to bed till convalescence is assured.

Every case in which the diagnosis of acute nephritis has been established, even though of slight severity, ought to be transferred to England for convalescence.

The question of the transport of these patients is an important one. With the exception of unusually protracted cases, they ought not to be sent across the seas while œdema is still present; and never until the urinary flow is fully re-established and all uræmic symptoms have disappeared. Cases of average severity may usually be sent to England about twelve days or a fortnight after their admission to the base hospital. If any active symptoms are present the long journey is injurious, and may even prove fatal.

The patients should be sent as stretcher-cases; and throughout the journey should be carefully protected from cold by a sufficiency of blankets, particularly in bad weather. Severe relapses have followed chills sustained in transit, at railway stations or in motor-ambulances.

Post-mortem Appearances.

Four cases terminated fatally; three of these were investigated by Captain H. G. M. Henry and are to be more fully described in a separate communication.

Three of the four cases showed undoubted evidence of long-standing renal disease, upon which an acute attack had been superadded.

In one of the cases (Case 1) neither history nor post-mortem

evidence of preceding renal disease was present. The patient, aged 21, had been taken ill during a period of severe fighting, and had been exposed to great hardships before admission; he first came under the writer's observation during the convulsions which terminated fatally. Death took place one week after the onset. Post-mortem: great general œdema; double pleural effusion; purulent bronchitis, with a granular condition of the trachea; spleen much enlarged and soft; kidneys congested, but otherwise showing no great macroscopic changes; capsules stripped readily; a few subcapsular cysts on the surface of one kidney. Microscopically, lesion essentially a tubular one, with swelling and desquamation of the epithelium; a few glomeruli showed proliferation of the cells; no interstitial changes.

Bacillus perfringens cultivated from spleen, probably a post-mortem contamination.

Case 2.—Aged 20: death from repeated hæmorrhages and exhaustion. Post-mortem: great general œdema; ascites; purulent bronchitis; dilatation of heart; kidneys large, pale, with a marbled appearance. Microscopically, old-standing parenchymatous nephritis, with degeneration of glomeruli; distended tubules and some interstitial change.

Case 3.—Aged 40: death from convulsions. Post-mortem: œdema of lower part of body; spleen slightly enlarged; mesenteric glands slightly enlarged; right kidney, impacted ureteral calculus, with hydronephrosis; left kidney congested, no obvious macroscopic change; no section preserved. Streptococci, in association with *B. coli communis* and a diplococcus, were grown from spleen, kidneys, and mesenteric glands, probably a post-mortem contamination.

Case 4.—Death from repeated hæmorrhages and exhaustion. Post-mortem: congenitally small and malformed kidneys with hypertrophied ureters.

Bacteriology.

Blood-cultures invariably proved sterile. Cultures of the urine also were usually sterile, although a few colonies of staphylococci or coliform bacilli were occasionally grown, probably as the result of contamination. Similar results were obtained in the lower-tract cases. It will be noticed that the results of cultures made from the organs post mortem were equally inconclusive.

Pathology and Causation.

Age.—For the sake of comparison the following table shows the average age of fifty consecutive cases of acute nephritis, and also the average age of fifty cases of each of four common maladies sent down the line and admitted during the same period :—

Nephritis	30 years.
Bronchitis	30 ,,
Influenza	28 ,,
Tonsillitis	25 ,,
Trench foot	22 ,,

Nephritis and bronchitis thus head the list ; and hence it appears probable that increased age is a predisposing factor.

Previous Renal Disease.—In about twenty-five per cent of the cases there was either thickening of the artery of the wrist, a history of previous renal disease, or both. It may be noted that of the four fatal cases three were found post-mortem to have been the subjects of long-standing renal disease, although in only one of them (Case 2) was this ascertainable during life. From the worn-out aspect of some of the patients, the writer is of opinion that a proportion higher than is clinically ascertainable are really the subjects of long-standing damage to the kidneys, which may be regarded as predisposing to the acute condition.

The search for ætiological factors has not hitherto thrown much light on the causation. Neither indulgence in alcohol, the drinking of chlorinated water, nor the eating of any particular food have yet been shown to be guilty. Exposure to cold can hardly be the essential factor, for the cases were common in the summer. In only two cases did the writer consider the condition to be syphilitic in nature.

Certain facts suggest that the process is an infective one. A few cases occurred early in 1915, and the numbers steadily increased during the spring and summer. This gradual increase in the number of cases is strongly suggestive of the growth and spread of some causal organism. Small outbreaks occur, several men being sometimes affected in one battalion within a few days. Orderlies employed in hospitals seem particularly liable to the disease ; on the other hand, officers are comparatively exempt. Most of the cases come from the trenches ; some, however, come from behind the line, and even from the base. The disease seems specially prevalent in the neighbourhood of Ypres. Further, the clinical aspect of the cases, the mode of onset, the febrile reaction, the furred tongue and pain in the limbs present the picture of an

acute infective process; the occasional occurrence of herpes and parotitis points in the same direction.

Although the disease appears to be due to an infection, the growth of the organism does not necessarily take place in the kidneys themselves; indeed the evidence on this point is all the other way. It may well be that the organisms multiply in some other part of the body, their toxins being brought to the kidney, and there setting up inflammation. The frequent association of tracheitis and bronchitis suggests the pulmonary tract as the nidus of infection.

Nothing is yet known as to the method of spread. One point may give the clue, namely, the comparative immunity of officers. The writer can only discover one ætiological factor bearing on this: The soldiers are very liable to slight septic infections, such as boils, sore fingers, and the like; officers, on the other hand, are not nearly so liable to these conditions. Many of the nephritis cases present septic foci of this nature; in two of the writer's cases the disease followed immediately after a severe septic infection of the hand. Rosenow ("Elective Localization of Streptococci," *Journal of American Med. Assoc.*, November, 1915) believes that special strains of streptococci may arise showing a predilection for certain organs; possibly such a strain may have a tendency to affect the respiratory tract, and subsequently the kidneys. It would be of interest to learn whether purulent bronchitis is more prevalent amongst the soldiers than amongst officers. Ophüls (*Journal of American Med. Assoc.*, November, 1915) suggests that in certain forms of nephritis organisms are brought to the kidneys by the blood-stream and are there destroyed, the toxins thus liberated giving rise to nephritis, while the urine might remain sterile; such cases would present a contrast to the many instances of septicæmia in which organisms pass through the kidneys and are found in the urine, although no nephritis is present.

As to whether the disease be due to one organism or to several and whether the kidneys be affected by the toxins or by the organisms themselves, appears to be essentially a bacteriological problem; and it may be hoped that further investigation will lead to another success in the campaign waged by military medicine against the diseases which affect the soldier in the field.

The writer expresses his obligation to Lieutenant-Colonel J. H. Campbell for facilities in investigating the cases at No. 11 General Hospital, and to Colonel Sir Bertrand Dawson for the interest he has taken in the work and for his valuable suggestions.

THE TREATMENT OF GUNSHOT WOUNDS OF THE LUNG AND PLEURA.

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THE conclusions upon which this paper is based were obtained from the study of forty-three consecutive cases of injury to lung and chest wall treated in hospital from September 1, 1915, to November 30, 1915.

These injuries were caused by rifle bullet, shrapnel ball and fragments of casing of shell and bombs; the cases arrived from seven to twelve days after the infliction of the wound.

In none of these cases had any surgical treatment, such as aspiration, been attempted on the P. or on the hospital ship.

The clinical signs presented by these cases were those of fluid or air and fluid in the pleural cavity, and for purposes of classification and essential treatment can be described under the headings hæmothorax, pneumohæmothorax, and pneumothorax.

HÆMOTHORAX.

There are three clinical varieties of this condition. First a massive hæmothorax with collapse of lung, the level of fluid rising to the clavicle. Second, an effusion of fluid with lung floating on top of the fluid level and compressed against the unyielding chest wall. Third, a minor degree of effusion, varying from a thin layer at the base to an amount that rises to the angle of the scapula; in this variety there is still presence of tactile vocal fremitus and vocal resonance in a degree varying with the amount of effusion.

In the variety with massive effusion up to the level of the clavicle there is complete absence of breath sounds and of tactile vocal fremitus. In the second variety there is usually loss of breath sounds and of tactile vocal fremitus up to the level of the fourth rib, while, above, there is " skodaic " resonance and increased harshness of breath sounds.

At the time the cases reached the hospital each variety of hæmothorax seems to have been definitely established, for in no case did either variety merge or become transformed into the other. By the seventh day from the infliction of the wound the amount of the effusion seemed to have been definitely determined.

Even in the cases of re-accumulation of fluid after aspiration the level of the fluid never rose above its original height. This appears to afford clinical justification for the established practice of waiting for some days, except in urgent cases of cardiac embarrassment, before aspiration is attempted.

There is a marked immobility of the chest corresponding in degree to the amount of effusion. The heart is dislocated to the other side in all cases of gross effusion of fluid, but the amount of embarrassment depends more upon the rapidity with which the effusion is poured out and the presence of coexisting pneumothorax than upon the actual amount of fluid. The development of the chest has an important bearing on the degree of cardiac embarrassment; the more capacious the chest the more room for the contralateral lung to expand.

There is also more cardiac embarrassment in cases of left-sided hæmothorax; the heart appears to tolerate dislocation to the left of the sternum more readily than to the right. In empyemata, where the fluid is under greater pressure in view of the protective attempts of pleural adhesions to wall in the effusion, and where the fluid is excreted more slowly, there is often very great cardiac dislocation with little embarrassment of cardiac action and dyspnœa.

The slight effusions of fluid invariably show tendency to rapid absorption, particularly after aspiration, even though only slight amounts of fluid are removed. Aspiration in these cases seems to upset the balance between excretion and absorption in favour of the latter process. These slight effusions often present the clinical paradox of a thin layer of fluid with a coincident coarse pleural rub, especially in expiration. This is due to the separation of pleural surfaces covered with clot of butter-like consistency. This is the only type of hæmothorax which shows a tendency to natural recovery and absorption, without aspiration, in a reasonable time.

HÆMOPNEUMOTHORAX.

In the majority of these cases the pneumothorax is apical, but there are cases, clinically very difficult to diagnose, in which there is a patchy pneumothorax even at the base of the lung. Here the air is imprisoned by adhesions and, masking the clinical signs, increases the difficulties of diagnosis. These localized collections of air do not appear, as a rule, to be under any very great pressure and present a natural tendency to absorption. In none of our

cases of pneumothorax was there any evidence of the presence of gas from gas-forming bacilli.

The condition of hæmothorax with apical pneumothorax presents an immobile barrel-shaped chest on the affected side, often with very marked bulging and dyspnœa, especially in the recumbent position. There is great displacement of the heart, greater and accompanied with more embarrassment than in gross hæmothorax or pneumothorax. The fatal cases in particular are of this type, death occurring from cardiac syncope. In left-sided apical pneumothorax the heart is so dislocated as to give the impression of torsion, as if there was acute kinking of the great vessels at the base of the heart by the degree and suddenness of the dislocation. The displacement of the heart varies with the pressure under which the air exists, and the embarrassment of that organ with the rapidity with which the air and fluid collect. The heart exhibits remarkable power of accommodating itself to varying degrees of pressure of air, and may show a diminishing degree of embarrassment as time goes on without a corresponding diminution in the amount of dislocation.

The clinical signs in these cases are those of fluid below the level of the fourth rib, as a rule, and the "box" note of pneumothorax above, with complete absence of breath sounds and tactile vocal fremitus. These signs transgress the middle line, and often show the distended pleura as far as two inches beyond the edge of the sternum.

Pneumothorax, pure and unaccompanied by hæmothorax, is very rare as a rule; a slight effusion is always present. So much air is absorbed during the first few days and during the subsequent period of observation that the physical signs may rapidly alter. The clinical signs presented in these cases are those of absence of breath sounds and vocal fremitus in a rigid, immobile, barrel-shaped chest. There is little doubt that these cases, arriving at M. after a considerable lapse of time, do not nearly represent the condition at the time of the original wound. In the field a number of cases are seen where the initial wound of the chest, more marked where the exit wound is in the front of the chest, are accompanied by ingress and egress of air; these wounds are either packed or closed up superficially. But on arrival in M. there is very little of the pneumothorax, which must have existed at the commencement of the voyage, to be discerned, so rapidly is air absorbed.

Clinical Value of Temperature.—As a guide to treatment the

study of temperature is valuable. All effusions of blood into the pleural cavity, with the possible exceptions of the minor degrees of hæmothorax, are accompanied by fever from 100° F. to 103° F. The fever is uniformly marked throughout the whole day and is not subject to great oscillations. This condition of fever is also exhibited in all extravasations of blood into serous cavities. It is due presumably to the absorption of fibrin ferment or other products of coagulation. Marked difference in the morning and evening reading is suggestive of empyema, more particularly when the tongue is furred and when the skin and conjunctivæ are jaundiced. An icteroid tinge is usually marked in the conjunctiva even in uninfected hæmothorax.

In cases of hæmothorax left untreated by aspiration the temperature tends to fall by the end of the second or third week, even though the physical signs of fluid still remain. Usually, however, coincident with the fall in temperature, appears a degree of return of tactile vocal fremitus and breath sounds. There is always a sharp fall in temperature after aspiration, though, in some cases, there is a tendency to rise again gradually after two or three days, but not to the previous height of fever. Re-accumulation of fluid is always accompanied by a sharp rise in temperature.

The development of empyema also is characterized by a gradual rise of temperature, with marked diurnal oscillations and other clinical evidences of pyogenic infection.

After efficient surgical drainage of empyemata there is a sharp drop in temperature; the fall is maintained until convalescence is over. If, after drainage of empyemata, there is a subsequent rise of temperature, it is found to be due to the presence of a quantity of infected clot. Not until this clot is removed by irrigation or by the exploring finger does the temperature finally subside. Only in the cases where it is necessary to remove infected clot is irrigation advisable.

Clinical Value of Hæmoptysis.—Only in 75 per cent of cases is there any hæmoptysis at any stage; 25 per cent only have an initial hæmoptysis when the wound is inflicted; 50 per cent of the cases have hæmoptysis about three days after being wounded. The early hæmoptysis is always bright red and consists of pure blood only; the hæmoptysis occurring on the third day is streaky and mixed with sputum, and may continue off and on for as long as two to three weeks. Aspiration has, as would be expected, a marked effect in the cessation of streaky hæmoptysis; blood-spitting, however, may reappear with fresh bleedings and

reaccumulations. There were no cases of pure hæmoptysis among those who arrived; these probably all die before they reach M., as also do the cases of rapid and gross pneumothorax. All the wounds, with one exception, seen by us in M. were closed and healed; they seldom appear to be of such size as to allow ingress and egress of air; this refers to wounds caused by shrapnel ball or rifle bullet. The extensive wounds with loss of bony rib, caused by shell casing, arrive in M. with established pneumothorax. The most dangerous of these wounds are those of a valvular nature, admitting air but not allowing egress of air. In these the presence of pneumothorax gradually increases; the dislocation of the heart is marked and the embarrassment of that organ grave. Immediate resection of a rib is urgently needed to relieve the great positive pressure inside the thorax.

Clinical value of dyspnœa as an aid to diagnosis and treatment is uncertain. At the moment of infliction of the wound there is a sharp pain in the chest and dyspnœa. Later on grave respiratory distress is not as common as would be expected. Most of the cases were able to adopt the recumbent position on board the hospital ship, but, during the process of disembarkation at M., some change seems commonly to occur, and on admission many cases of effusion, and especially of hæmopneumothorax, are in great respiratory and cardiac distress; they can only rest in comfort in the orthopnœic position. Aspiration or resection of a rib has an immediate and beneficial effect upon true dyspnœa; dyspnœa with cardiac displacement is an absolute indication for aspiration. It is surprising how great an amount of fluid and air is tolerated in the pleural cavity in men with big and roomy chests; in individuals with narrow, contracted chests a slight degree of effusion will sometimes cause a grave dyspnœa.

Surgical emphysema is often remarked in the neighbourhood of the exit wound—usually local, but sometimes general. It is in the majority of cases only in the neighbourhood of the exit wound and can be explained by the fact, so constantly established at autopsy, that the exit wound is plugged by lung tissue. Coughing or any violent expiratory effort is sufficient to force air into the tissues. More particularly in the case of perforating shrapnel wounds is this surgical emphysema seen. Surgical emphysema is of academic interest only and does not seem to affect the progress of the case. In one of our cases there was a hernia of the lung beneath the unbroken skin, where a shrapnel ball had broken the rib without perforating the skin.

The position of the wound in the lung seems to affect the incidence and amount of hæmo- and pneumo-thorax. Wounds, the track of which can be estimated by the exit and entry wounds, passing obliquely through the apices or anterior margins of the lung, are more commonly associated with pneumothorax and not with gross hæmothorax. Wounds passing directly through the lung, especially in the neighbourhood of the root of the lung, are associated more often with the massive effusions. One of our cases, complicated by an aneurysm of the first part of the axillary artery, was an instance of gross hæmothorax from a wound of the axillary vein. In this case after two large aspirations the wound in the vein healed; here the fluid remained uninfected throughout. The third part of the subclavian artery was subsequently ligatured with great success.

The clinical value of colour of the effusion after aspiration is very great. In cases where a prompt bacteriological examination both by slide and by cultivation is not possible or valuable time cannot be spared, determination of empyemata by smell, colour and deposit can be made. Effusions are very varied: they are clear and colourless, cloudy and turbid, clear port-wine red, bright scarlet with deposit, chocolate colour, opalescent and greenish, pale pink with deposit. The clear port-wine red is characteristic of uninfected effusions and is the effusion most commonly met with. Effusions with deposits are always suspicious. Chocolate-coloured and opalescent effusions are certainly empyemata. All smelly effusions also are, without doubt, empyemata.

The reports of bacteriologists bear out this rough colour test very generally. The pleural effusions are not all pure hæmothorax by any means. There is always a mixture of blood with pleural effusion due to trauma and irritation of the pleural surface, just as will be found in ordinary medical cases of general effusion. For the blood in the pleural cavity acts as a foreign body and sets up pleural irritation. One of our cases of bomb wound of the thorax was characterized by a clear pleural effusion, apparently purely traumatic. It is this admixture of pleural effusion with blood from the vessels of the injured lung which probably accounts for the fact that effusions of blood-stained fluid in the pleural cavity, and after aspiration, do not conform to the usual rules governing clotting of blood. None of the pleural effusions behave in the recognized way as regards coagulation. The regular separation of serum and fibrin is not to be recognized in fluid obtained by aspiration after prolonged standing. The reaccumulation of fluid is not

due to true secondary hæmorrhage from the wound in the lung, but rather to a pleuritic effusion tinged with colour from the remaining clot.

The condition of the contralateral lung and pleural cavity has an important bearing on the treatment. In many cases there is a marked bronchitis, probably from hypostatic congestion; and in some cases a true lobar pneumonia of the other lung complicates the case. Here the value of aspiration is most marked. Cough, hitherto almost constant, causing the greatest damage to the wounded lung, clears up immediately after aspiration. We have had cases of bronchitis, with an amount of sputum sufficient to fill one or more pint pots in the day, clear up at once after aspiration in a most remarkable way. Similarly pneumonia of the uninjured lung shows a tendency to rapid progress towards cure—marked diminution in the respiration-rate, distress, dyspnœa and fever.

In one of our cases of true emphysema is an elderly fibrotic man; aspiration of a moderate effusion only had a most marked effect in the improvement of the bronchitis in the contralateral lung.

X-ray findings are of great value, especially in those cases where the presence of patchy pneumothorax masks the symptoms, and when, after ineffectual needling of the pleural cavity, the signs of fluid still persist. The dislocation of the heart is clearly visible, and the cardiac pulsation that can be felt immediately below the right clavicle in cases of gross effusion is apparently conducted from the right ventricle. There is suggestive evidence of a rotation of the heart upon the great vessels. The diaphragm is fixed and immobile, and very greatly depressed by the effusion, for blood is a very heavy fluid. This bears out the immobility of the affected side of the abdomen which, clinically, is correctly attributed to a fixed and immobile diaphragm. Pneumothorax shows up as a clear bright area which transgresses the middle line as the pleural cavity in question is distended.

The diagnosis of emphysema is helped by screening. There is no level of shifting dulness as is seen in recent hæmothorax or hæmopneumo-thorax. The dark area is seen fixed by adhesions. In empyemata there is marked displacement of the heart, far greater than the amount of dyspnœa would lead one to believe; the slight amount of cardiac embarrassment is due to the ease with which the heart accommodates itself to gradually increasing intra-thoracic pressure.

Later on, the X-ray is not reliable in determining the difference

between fluid and thickened pleura or organizing clot. Here an aspirating needle is far superior and more reliable than the X-ray or the stethoscope.

The treatment of wounds of the lung and chest wall is directed towards healing the injured lung vessels and the leak in the smaller bronchioles or alveoli, from which the air escapes into the pleural cavity. To this end absolute rest in a recumbent position, unless there is dyspnœa from respiratory or cardiac embarrassment, is essential for at least three weeks; this is followed by comparative rest for another three weeks. In no case has any patient suffering from perforating wound of the lung been sent to England under six weeks from the time of admission. The proof of this lies in the fact that only one of our thirty-seven cases, sent by hospital ship to E., has developed fresh accumulation of fluid on the voyage or upon arrival in E. None of our cases has developed the sudden pneumothorax which is the danger of too early and rapid convalescence. In cases of dyspnœa the sitting-up posture is adopted.

In one of our earlier cases of hæmothorax, in which aspiration had removed the effusion and, beyond slight thickening of the pleura, the patient appeared to be well, a sudden attack of syncope developed after slight exertion three weeks after admission. Clinical examination showed a rapid reaccumulation of fluid and an apical pneumothorax, but before aspiration could be attempted death supervened. The condition was confirmed at autopsy.

During the period of absolute rest in bed, the patient is not allowed to wash his own face or perform any duty for himself nor to use his arms, while all attempt at straining or exertion is forbidden.

The drug treatment adopted consists in the regular administration of urotropin to keep the pleural effusion from becoming infected, and of substances to promote coagulation of blood and to contract the muscular tissue of the minor vessels of the lung. Morphine and ergotinin citrate have been largely administered for their effect upon the blood-vessels, and animal serum to promote coagulation. Of these measures we have felt inclined to place most value in regular injections of serum; in default of horse serum we have been in the habit of using antistreptococcic serum. This serves the double purpose of promoting coagulation and correcting possible infection by some strain of streptococcus. The bacteriological findings show that the streptococcus is the dominating organism in the empyemata which may subsequently develop. Enemata of calcium chloride for three days at the commencement

of treatment have also been given with a view to promote coagulation.

The treatment of effusion is by early aspiration in every case in which there is clinical evidence to lead to the belief that any considerable amount of fluid can be withdrawn. This may be repeated weekly in uninfected cases. In no case has aspiration been attempted before the seventh day, for our cases have not reached us in M. until seven to twelve days have elapsed from the infliction of the wound. If aspiration is conducted slowly, and a careful watch upon the respiration and heart be maintained, as much as three pints may be slowly abstracted without any dangerous symptoms; a large trocar and cannula or a Dieulafoy evacuator may be used. In every case there is relief of symptoms of heart and lung disturbance, and a feeling which is constantly described as of "comfort" in the chest.

In the minor degrees of hæmothorax or effusion there is no necessity for aspiration, as this condition clears up rapidly under expectant treatment; in any case only a few drops of fluid can be obtained and with a big needle there is always a risk of producing a pneumothorax.

In our earlier cases we were in the habit of cocainizing the skin and the pleura before aspiration, but we discovered that the most careful cocainization with 2 per cent novocain could not be certain of blocking the intercostal nerves, which are compressed between the cannula and the rib at each expiratory movement. There is also great emotional distress when the process of aspiration is continued, as it has to be, for fifteen to twenty minutes. To avoid the risk of movement all operations are conducted in bed in the ward. For this reason we employ chloroform, after a preliminary injection of morphine and atropine, in every case; and the orthopnœic position is adopted. This position ensures the most complete evacuation of fluid and causes the least embarrassment to the contralateral lung. The employment of a general anæsthetic gives complete comfort and absence of emotional disturbance.

In no case has there been any respiratory or cardiac difficulty arising from chloroform, and the pulse improves most markedly during the process of aspiration. In the cases of urgent dyspnœa and cardiac embarrassment, due to gross effusion and the pressure of an apical pneumothorax under great positive pressure, the administration of chloroform has been attended with the greatest success. There is always an element of fear in these cases of extreme dyspnœa and palpitation which is corrected by the general anæs-

thetic, so much so that improvement is observed before the aspiration is commenced.

Displacement of the heart is always an indication for aspiration. We have always found that the cases which are most likely to develop grave symptoms are those in which an apical pneumothorax exists with a gross hæmothorax. In these cases the displacement of the heart is extreme. The pressure of air also is liable to sudden increase, resulting in syncope.

Especially is this sudden increase of pressure in a pneumothorax to be feared in the cases with persistent cough.

Among our earlier cases were some with considerable effusion treated only by drug and expectant treatment. The clinical result after two months' observation and X-ray examination was interesting. The diaphragm remained fixed and comparatively immobile, even in deep inspiration; there was much flattening of the chest on the affected side, and clinical evidence of very great pleural thickening, as shown by wooden dulness and diminution of breath sounds, combined with a return of vocal resonance and tactile vocal fremitus. Respiratory exercises begun with care did not appear to effect much result before the patients were transferred.

The treatment of pneumothorax is called for by the amount of intrathoracic positive pressure; this is to be judged by the degree of cardiac displacement and the severity of the dyspnœa and palpitation. Death occurs often from heart failure and dilatation of the right heart owing to the rapid dislocation of that organ. Aspiration of the fluid or resection of a rib relieves the pressure of air without any necessity of withdrawing air in cases of gradual collection; but in acute and rapid pneumothorax it is necessary not only to empty the chest of fluid but also of air. We believe that early resection of a rib in selected cases is most valuable. In the majority of cases, air is more or less rapidly absorbed, especially if a coexisting hæmothorax is aspirated. There was no case in this series of the collection of gas due to gas-producing organisms.

Empyemata developed in less than ten per cent of the cases comprising this series. The cause, except in the cases of fracture of ribs with a ragged external wound caused by fragments of shell and bomb casing, is largely due to infection from within, from the interior of the lung. Bacteriological examination of the fluid obtained by aspiration showed the presence of streptococci, staphylococci and bacilli presenting all the variety of morphological characters of mouth organisms. In empyemata the streptococcus is the dominant organism, though, at first, its presence may be

masked by other coexisting forms. Effusions with deposit on standing, chocolate or opalescent green fluids are always to be treated as empyemata without waiting for bacteriological confirmation.

The treatment is resection of a low rib; as the diaphragm is depressed by the weight of blood effused, it is easy to resect a portion of the tenth rib and to obtain thereby excellent drainage. Temperature falls at once after this operation and remains low; if, however, there is a recrudescence of fever the cause must be looked for in the infection of clot. This clot should be removed by careful manipulation with the gloved fingers; care is to be taken that fresh bleeding does not result from injury to the wound in the lung. Only in the cases of infection of the clot is irrigation advisable; in the cases of foul discharge—and in some cases there is a *Bacillus coli* infection superimposed—irrigation with hypochlorite solution or iodoform in ether rapidly clears up the odour and profuseness of the discharge.

The clinical diagnosis of empyema is helped by X-ray examination; the fixation and immobility of the diaphragm, the displacement of the heart and the shadow of the effusion are well shown. There is no level of shifting fluid as is seen in early cases of hæmothorax; in empyema the effusion is limited by pleural adhesions.

But the aspirating needle is of greater value than the X-ray or the stethoscope. For, owing to the thickening of pleura, there is often much masking of the clinical signs.

No attempt should be made to remove rifle bullets or shrapnel balls lodged within the lung or chest wall unless they are quite superficial, or unless at a subsequent resection of rib the projectile comes easily within reach.

Operation findings, when a rib has to be resected, show the value of early aspiration. The exploring finger finds a mass of semi-organized clot, often one inch deep, covering the diaphragm and filling the sulcus between the diaphragm and the parietal pleura.

In cases of fracture of ribs with ragged external wound great care must be taken to explore and thoroughly drain the original wound. Broken and comminuted fragments of rib are very liable to acute spreading osteomyelitis, which, by causing pain and much irregular temperature, may cause erroneous conclusions to be drawn with regard to the condition of the interior of the pleural cavity.

One of the cases of this series was instructive: a ragged external

wound with fracture of ribs resulted in a valvular wound opening into the pleural cavity. Air was sucked in at inspiration, but the egress of air was prevented by the valvular opening. There was a rapidly progressive pneumothorax with great displacement of the heart and urgent symptoms. Immediate resection of a rib allowed free air exit and corrected the cardiac condition.

Post-mortem examination provides the essential confirmation to the clinical conclusions. In cases of apical pneumothorax there is an escape of air under positive pressure when the pleural cavity is opened. In cases of empyema there is great thickening of the parietal pleura with semi-organized and adherent clot.

The lung wounds are instructive. Clean perforating wounds are not seen in the cases which come to autopsy. There is much tearing and laceration of lung tissue. The lung is firmly adherent, by bands of lung tissue the thickness of the finger, to the entry and to the exit wound. The exit wound, in the cases of perforating wound by shrapnel ball, is plugged with lung tissue, thus accounting for the cases of surgical emphysema in the neighbourhood of the exit wound.

In one case of this series the pulmonary vessels were thrombosed from an injury caused by shrapnel ball not amounting to solution of continuity of the vessels.

Here the whole lung had broken down into a grangrenous and friable pulp. The physical signs in this case were particularly misleading.

Infarction of the lung, red hepatization of true lobar pneumonia, hypostatic congestion and much thickening of the visceral pleura are observed in cases of long standing.

The heart remains fixed in its position of displacement in cases of empyema of long standing. This is also observed in cases where there is long delay before aspiration is performed in cases of hæmothorax. Even after aspiration within ten days of the development of the hæmothorax the displacement of the heart is very slowly corrected; by clinical examination the apex beat only slowly returns to its former position.

Where the lung is floated up upon the surface of fluid, rising to about the level of the fourth rib, it is compressed between the fluid and the unyielding chest wall. At autopsy the anterior margins and surface of the lung are emphysematous and the margin of the lung is pushed across the mid-sternal line.

A specially well-aired ward was established at ——— Hospital for the sole care of these cases of wounds of lung and chest wall.

One advantage lies in the removal of these cases from contact with surgical cases of compound septic wounds of long bones and cases of gangrene and cellulitis. This care has been justified by the small number of cases of infected hæmothorax; of this series only six cases of empyema developed. There is also the additional advantage of continuity of treatment at the hands of one medical officer and the special organization which leads to swiftness and accuracy in performing aspiration or resection of rib.

Of this series there have been six deaths: two from empyemata, in which the clot became so infected as to poison profoundly the patients in spite of attempts at complete removal of infected clot and lavage. Four deaths occurred from rapid development of apical pneumothorax in cases of hæmothorax.

To Colonel Gulland, A.M.S., for the special care in supervision of our treatment of wounds of the lung and pleura the credit of our success in the treatment of this condition is due.

REPORT ON THE RESULTS OF THE BILHARZIA MISSION IN EGYPT, 1915.

BY R. T. LEIPER, D.Sc., M.B.
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(*Continued from p.* 261, *vol. xxv*, 1915.)

PART IV.—EGYPTIAN MOLLUSCA.

Based largely upon a typical set partly collected and arranged
BY J. GORDON THOMSON, M.A., M.B.[1]
Protozoologist to the London School of Tropical Medicine.

As a preliminary to the systematic dissection of molluscs for developmental stages of trematodes it was thought essential to form a typical set of the various species of Egyptian Mollusca for reference. Through the courtesy of Major Flower and Messrs. Nicoll and Bonhote, we were given full liberty to make an exhaustive examination of the various ponds in the Zoological Gardens, Giza. These waters proved particularly rich in molluscan fauna, and, as will be noticed from the localities given under each species, provided typical examples of the bulk of the recorded forms.

Molluscs are, generally speaking, essentially aquatic animals, but a certain number are adapted to terrestrial life. The latter are of interest in relation to these investigations only in so far as they may be found living on the weeds overhanging the canals or dead in the mud dredged for aquatic forms. A certain number which came under our purview in this way are put on record.

The larval metamorphosis of all digenetic trematodes occurs without known exception in the bodies of molluscs belonging to the classes Gastropoda and Lamellibranchia, which are comprised in the grade Prorhipidoglossomorpha, and are alike distinguished by the possession of a visceral commissure, a foot wholly posterior to the head and a separation of direct communication between gonads and pericardium.

The large majority of trematode larvæ develop in the Gastropoda. The Gastropoda are specially characterized by a univalve shell, an asymmetrical organization and a well-developed head, while the Lamellibranchia have a bivalve shell, an internal and external symmetry and a rudimentary cephalic region.

The shells collected are described in accordance with the classification set out in the following table; in every case the diagnosis

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is provisional and is based upon a comparative study of the material with the figures and description given by Pallary in his "Catalogue de la Faune malacologique de l'Egypte," published in Cairo in 1909.

CLASS GASTROPODA.

- EUTHYNEURA
  - Opisthobranchia
    - Tectibranchia (marine forms)
    - Nudibranchia (marine forms)
  - Pulmonata
    - Stylommatophora
      - Helicidæ
        - HELIX.
        - EREMINA.
      - Pupidæ
        - LEUCOCHILOIDES.
        - CALAXIS.
      - Succineidæ—SUCCINEA.
    - Basommatophora
      - Planorbidæ
        - PLANORBIS.
        - BULLINUS.
        - PYRGOPHYSA.
      - Physidæ—PHYSA.
      - Limnæidæ—LIMNÆA.
      - Ancylidæ—ANCYLUS.
- STREPTONEURA
  - Aspidobranchia
    - Docoglossa
    - Rhipidoglossa—Neritidæ—NERITINA.
  - Pectinibranchia
    - Tænioglossa—Platypoda—
      - Paludinidæ
        - VIVIPARA.
        - CLEOPATRA.
      - Ampullaridæ
        - AMPULLARIA.
        - LANISTES.
      - Valvatidæ—VALVATA.
      - Hydrobiidæ
        - BYTHINIA.
        - HYDROBIA.
      - Melaniidæ—MELANIA.
    - Stenoglossa
      - Toxiglossa
      - Rhachiglossa

CLASS LAMELLIBRANCHIA.

- Eulamellibranchia—Submytilacea—
  - Cyrenidæ—CORBICULA.
  - Cycladidæ
    - CYCLAS (SPHÆRIUM).
    - PISIDIUM.
    - EUPERA.
  - Unionidæ
    - NODULARIA.
    - LAMELLIDENS.
  - Mutelidæ
    - MUTELA.
    - SPATHA.

GASTROPODA.

HELICIDÆ.

Helix (Hygromanes) obstructa, Ferussac, 1821.

Common among the overhanging grass along the edges of the ponds in the Zoological Gardens at Giza.

FIG. 56.—*Hygromanes obstructa.* (× 2.)

Stated by Pallary to be common throughout the Delta, but not found by us elsewhere than above.

Helix (Cochlicella) barbara, Linnæus, 1758.

Common in the Zoological Gardens, Giza, associated with *Hygromanes obstructa*.

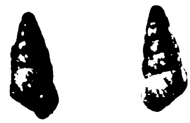

FIG. 57.—*Helix barbara*. (× 2.)

Recorded by Pallary as not uncommon around Alexandria.

Eremina desertorum, Forskal, 1775.

Common on the Mokattam Hills east of Cairo. Is said to occur over the whole Desert of North Africa from South Tunis to the Red Sea. This species has a remarkable capacity of withstanding adverse conditions. A specimen stuck down on a tablet in the British Museum, 1846, was found to be alive four years later, and survived two more years. The Rev. A. H. Cooke kept ten examples alive in a tin box without food for eight years.

FIG. 58.—*Eremina desertorum*. (× 1.)

An additional point of interest attaches to this species from the fact that in all probability it was the one upon which the survivors of H.M.S. "Tara" are reported to have fed during their captivity with the Senussi near Sollum prior to their rescue by the Duke of Westminster's armoured car detachment in the spring of 1916.

PUPIDÆ.

Leucochiloides sennaaricus, Pfeiffer, 1855.

FIG. 59.—*Leucochiloides sennaaricus*. (× 3.)

Shells only, recovered from the fine mud dredged from the artificial ponds in the Zoological Gardens at Giza. Not frequent.

Teilhard has found it in abundance at Matarieh and occasionally in the Wadi Hoff near Helwan.

Calaxis unidentata, Jickeli, 1874.

Collected with *L. sennaaricus* from mud dredged in the ponds at the Giza Zoological Gardens.

FIG. 60.—*Calaxis unidentata.* (× 3.)

Reported as common at Matarieh and around Alexandria.

SUCCINEIDÆ.

Succinea cleopatræ, Pallary, 1909.

(? *Succinea ægyptiaca*, Ehrenberg, 1830.)

Several specimens collected from reeds in marshy land on the desert side of the Ismailia Canal south of Bilbeis. A single

FIG. 61.—*Succinea cleopatræ.* (× 1½.)

example taken on the Sweet Water Canal near its connection with Lake Timsah.

Reported from the Mahmoud Canal and Lake Hadra near Alexandria, and from Nefisha near Ismailia.

PLANORBIDÆ.

Planorbis boissyi, Potiez and Michaud, 1838.

Next to *Bullinus dybowski* this is the commonest mollusc in the small canals and ditches round Marg. We found it plentiful also on the road to Bilbeis from the south in a small canal running parallel to the Ismailia Canal. In the marshes to the south-west of the town of Ismailia it was also abundant. In other localities where we collected around Cairo and in the ponds of the Zoological Gardens it appeared to be entirely absent.

Pallary records specimens from the canals at Alexandria, at Samanoud and Cairo — "in a word, throughout Lower Egypt." From our experience, however, it certainly appears to have a very limited distribution as compared with *Bullinus* and other common forms in the Delta.

FIG. 62.—*Planorbis boissyi*. (× 1.)

In the Sudan, where intestinal schistosomiasis is fairly common, this species has a wide distribution. Mrs. Longstaff has recorded finds at the following places on the course of the White Nile: north and south of Lake No; at Abba Island, Hillet Abbâs, Gebel Ên, Bahr-el-Zarâfa, and Hillet-al-Nûwêr. The Swedish Expedition collected numerous young examples at Gebel Ahmad Aga. These places are shown on the accompanying map.

Planorbis laurenti, Bourguignat, reported from Lake Timsah and from marshes near Ismailia, appears to be the same as *P. boissyi*.

P. boissyi is the intermediate host of Bilharzia mansoni in man in Egypt. The Cercaria of Bilharzia mansoni is shown in fig. 45. *It harbours also the developmental stages of a second species of bilharzid worm believed to attain maturity in an aquatic bird.*

Planorbis (*segmentina*) *angusta*, Jickeli, 1874.

A single shell of this species was given to us by Dr. Innes, from

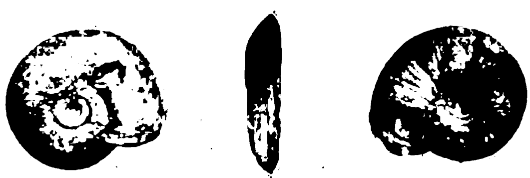

FIG. 63.—*Planorbis* (*segmentina*) *angusta*. (× 3.)

his collection made on the White Nile. We have found dead specimens in our field work. It is recorded from the shore of Lake Mariout, near Mex, Alexandria.

Planorbis mareoticus, Innes, 1884.

This small *Planorbis* is very common in the ponds at the Zoological Gardens and elsewhere in Giza. Specimens were frequently found at Marg.

FIG. 64.—*Planorbis mareoticus.* (× 1½.)

Pallary says that it is found at Damanhour, Nefische, near Ismailia, and is very common around Alexandria.

Ancey is of opinion that this form is the same as *P. ehrenbergi*.

P. mareoticus is the intermediate host of a cercaria believed to be the infective stage of a species of bilharzid worm occurring in aquatic birds.

EGG DEPOSITION IN PLANORBIDÆ.

Among the fresh-water molluscs at Marg we noticed two types of reproduction. There were certain forms like *Vivipara* and *Melania* in which the eggs were retained until development had taken place to such a degree that the progeny were provided with a shell showing already characters of the adult.

FIG. 65.—An egg-mass of *Bullinus* sp. deposited on weed.

In other forms, such as *Bullinus* and *Planorbis*, the eggs were found deposited in flat jelly-like masses on weed from the bottom and sides of the stream. Not infrequently similar gelatinous masses were found on the shells of *Planorbis* and *Bullinus*. That these were deposited by the individual actually inhabiting the shell seemed little probable.

Bullinus contortus, Michaud, 1829.

Common in the ponds of the Zoological Gardens, Giza, at Marg, and on the Sweet Water Canal, usually associated with *B. dybowski*.

FIG. 66.—*Bullinus contortus*. (× 2.)

Mrs. Longstaff has found it at Lake Shambe and at Masran Island on the White Nile. It has a very wide range, being reported from North, West and South Africa, Abyssinia, the Euphrates, and South Europe.

B. contortus is one of the intermediate hosts of Bilharzia hæmatobium (sens. strictu) in man in Egypt.

Bullinus dybowski, Fischer, 1891.

Very common in the ponds at the Zoological Gardens, at Marg, on the Sweet-water Canal and generally in the canals and birkets.

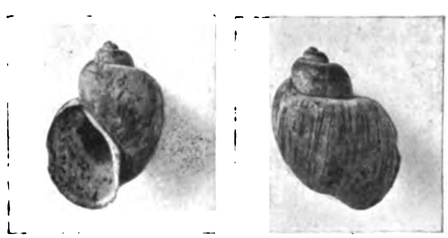

FIG. 67.—*Bullinus dybowski*. (× 2.)

Teilhard records it from Matarieh, and Pallary notes its occurrence in the collections of Lhotellerie from around Alexandria. This form is said by Pallary to be that provisionally named by Dr. Innes *Physa alexandrina* and appears in the lists of Sonsino and Looss under this synonym.

B. dybowski and B. alexandrina are intermediate hosts of Bilharzia hæmatobium (sens. strictu) in man in Egypt. The cercaria is shown in fig. 47.

Bullinus innesi, Bourguignat.

A number of specimens found associated with the two pre-

ceding forms at Marg. Teilhard obtained specimens at Matarieh and Lhotellerie from the Mahmoud Canal near Alexandria.

FIG. 68.—*Bullinus innesi.* (× 2.)

Bullinus innesi on some occasions was found infected with cercariæ of Bilharzia hæmatobium (sens. strictu).

Bullinus (*Pyrgophysa*) *forskali*, Ehrenberg, 1831.

Fairly common in the canal in the village at Marg and in the small subsidiaries. It was apparently absent from the Zoological Gardens. It is stated by Pallary to occur throughout the course of the Nile. In the Sudan Mrs. Longstaff found a specimen alive in

FIG. 69.—*Bullinus* (*Pyrgophysa*) *forskali.* (× 2.)

Lake Shambe, and Dr. Innes describes material from a marsh near the Blue Nile.

Bullinus (*Physopsis*) spp.

Pallary considers the records of the occurrence in Egypt (Damanhour) of this sub-section of the genus *Bullinus* as referable to young specimens of *Physa acuta* and *P. subopaca.*

(?) *Physa acuta*, Draparnaud, 1805.

Some specimens collected from a pond north of Suez and submitted for diagnosis by Lieutenant-Colonel A. Balfour, C.M.G., appear to belong to this species. They closely resembled the species illustrated in fig. 70, but were twice the size.

Physa subopaca, Lamarck, 1841.

Fairly common in a small irrigation canal in the public gardens south of the outflow branch of the Sweet Water Canal passing

FIG. 70.—*Physa subopaca.*

through the town of Ismailia. A few examples got in Giza Canal. Found at Ismailia also by Letourneux, at Matarieh by Teilhard, and around Alexandria by Lhotellerie.

LIMNÆIDÆ.

Limnæa cailliaudi, Bourguignat, 1883.

At Marg, but not in very large numbers.

FIG. 71.—*Limnæa cailliaudi.* (× 1½.)

Letourneux obtained this species on the shores of Choubrah Island, a few miles to the north of Cairo. A small variety has been found at Alexandria and Ismailia.

Limnæa alexandrina, Bourguignat, 1883.

Common in the Zoological Gardens, in the fountain of Shepheard's Hotel garden, and in the ponds in Esbekieh Gardens,

FIG. 72.—*Limnæa*, sp. inq. (× 1½.)

Cairo; and in collections of water generally where there is considerable weed.

In marshy pools on the desert side of the Ismailia Canal near Bilbeis a peculiar variety [Fig. 72] of *Limnæa*, differing apparently from those recorded for Egypt, was found in numbers.

(?) *Limnæa truncatula*, Müller.

Found in large numbers in small irrigation channels on the Island of Gezireh, in the ponds in the Zoological Gardens, Giza, and in irrigation channels in agricultural land south of Bilbeis. This form, curiously enough, is entirely absent from Marg.

The specimens differ slightly, but apparently constantly, from typical examples of this species received from England, and there is some probability that the Egyptian material should be placed

FIG. 73.—*Limnæa truncatula*, inq. (× 1½.)

under a separate category. Pallary states, however, that *L. truncatula* and a variety *minuta* is found throughout the course of the Nile.

The occurrence of this form in large numbers in Egypt is apparently overlooked by Looss in his discussion on the carrier of the liver-fluke of sheep and cattle in Egypt.

ANCYLIDÆ.

Ancylus clessini, Jickeli, 1882.

A few specimens of this small limpet were occasionally found on dead leaves dredged from the bottom of the ponds in the Zoological Gardens, Giza. The species has been recorded once previously, and was collected by Lhotellerie at Alexandria.

PALUDINIDÆ.

Vivipara unicolor, Olivier, 1801.

Of constant occurrence in all our collections. Very common in the ponds at the Zoological Gardens and at Marg.

Stated by Pallary to occur throughout the course of the Nile and its tributaries.

Like other operculated forms it can survive for a considerable period without water.

FIG. 74.—*Vivipara unicolor*. (× 1½.)

There are a number of varieties, based upon colour and ridges on the shell.

Cleopatra bulimoides, Olivier, 1804.

Widespread in distribution and of common occurrence. Found in numbers in mud from canals, at the Zoological Gardens, at Marg, and elsewhere.

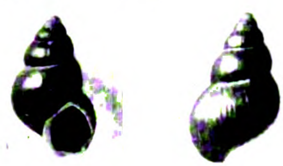

FIG. 75.—*Cleopatra bulimoides*. (× 1½.)

Stated by Pallary to occur throughout the course of the Nile.

We distinguished specimens of this species provisionally from the succeeding form by the brown spiral marking of the shell.

Cleopatra cyclostomoides, Küster, 1852.

Common and found in association with the preceding form, from which we distinguish it empirically by its greenish uniform coloration.

There appears to be a number of varieties of shell types in *Cleopatra bulimoides*.

AMPULLARIDÆ.

Ampullaria ovata, Olivier, 1804.

Found only, but in considerable numbers, in the Bahr Yusef in

the Fayum. There are records of its occurrence in Lake Mariut and in the Mahmoudieh Canal near Alexandria.

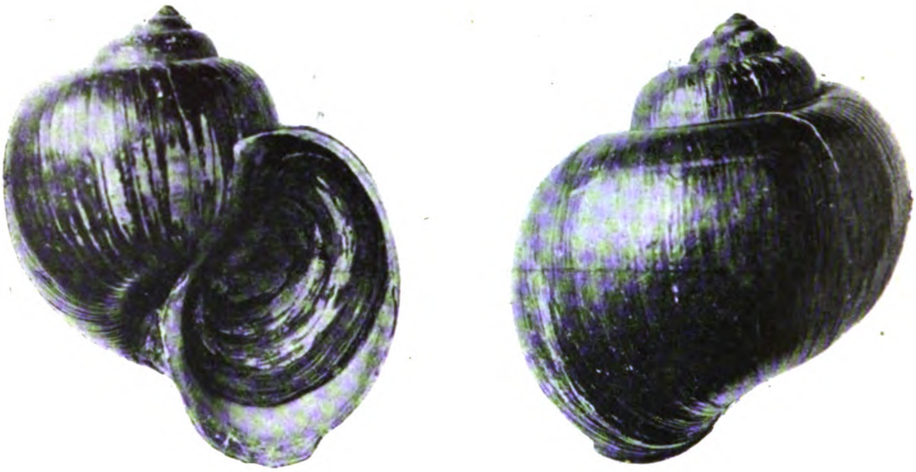

FIG. 76.—*Ampullaria ovata*. (× 1.)

Lanistes bolteni, Chemnitz, 1786.

Fairly frequent in the Marg Canal in and beyond the village. Some examples dredged from the ferry across the Sweet Water Canal in the town of Ismailia.

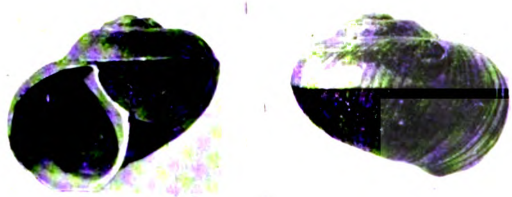

FIG. 77.—*Lanistes bolteni*. (× 1.)

It is said by Pallary to occur along the whole course of the Nile.

VALVATIDÆ.

Valvata nilotica, Jickeli, 1874.

This minute form occurs in numbers on dead leaves in the ponds in the Zoological Gardens, Giza. Examples were also collected from the large Giza Canal. It occurred only very occasionally at Marg.

Pallary has specimens from Alexandria, Cairo, and Suez. He states that it is distributed along the Nile and its tributaries.

FIG. 78.—*Valvata nilotica.* (× 2.)

HYDROBIIDÆ.

Bythinia (Gabbia) sennaarica, Parreyss, 1853.

About eighteen specimens in all occurred amongst the material collected from Marg. A few examples were found in the ponds of

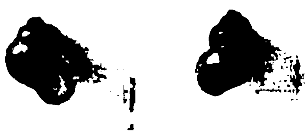

FIG. 79.—*Bythinia (Gabbia) sennaarica.* (× 2).

the Zoological Gardens, Giza, and a couple were dredged from the ferry over the Sweet Water Canal at Ismailia.

Pallary does not give specific localities, but says that it is distributed along the whole Nile. Mrs. Longstaff collected specimens from "ponds near the Pyramids of Gizeh" and at several places on the White Nile.

Hydrobia stagnalis, Linnæus.

We failed to find this form. It is reported by Pallary to occur in Lake Mariout, Alexandria, and at Rosetta. Smith mentions its

FIG. 80.—*Hydrobia stagnalis,* Bgt. (× 2.)

presence in Lake Qurun, Fayum and Jickeli lists it for North-East Africa.

MELANIIDÆ.

Melania tuberculata, Müller, 1774.

This is a very common form lying usually on the surface of the mud at the bottom of canals, ponds and birkets. It varies greatly in size. The largest forms collected were those obtained from the ponds in the Zoological Gardens.

Specimens were less frequent at Marg than *Vivipara* or *Cleopatra*. Pallary's records are from the neighbourhood of Alexandria, from Asswan and from Suez.

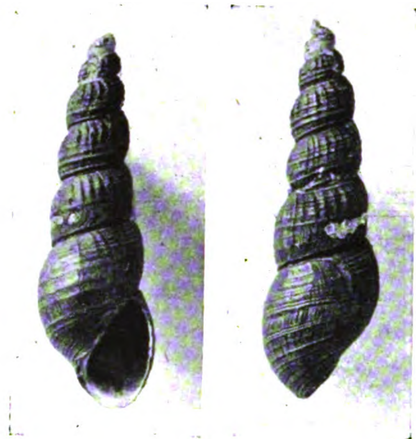

FIG. 81.—*Melania tuberculata*. (× 1½.)

In the bed of a small channel running from a spring into Lake Timsah between Ismailia and Ferry Post very large numbers of a small black variety were readily discernible on the sandy bottom.

Melania tuberculata harbours the developmental stages of a bilharzid worm believed to attain maturity in some aquatic bird.

LAMELLIBRANCHIA.

CYRENIDÆ.

Corbicula consobrina, Cailliaud, 1828.

In the mud of all the ponds and canals examined this bivalve

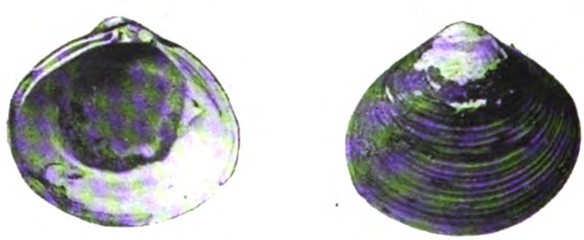

FIG. 82.—*Corbicula consobrina*. (× 1.)

occurred in large numbers. On the newly made banks of the tertiary canals, resulting from the annual removal of the mud from

the bed of the canal, enormous numbers of dead and disintegrating shells can always be seen.

Pallary gives no locality but says that this species is very common in all the waters of Egypt.

CYCLADIDÆ.

Cyclas (*Sphærium*) *teilhardi*, Pallary, 1909.

A few examples were collected from the ponds in the Zoological Gardens at Giza.

FIG. 83.—*Cyclas* (*Sphærium*) *teilhardi*. (× 1½.)

Pallary bases the species on material collected at Gabbari near Alexandria.

MUTELIDÆ.

Spatha rubens, Lamarck, 1819.

A few examples of this enormous bivalve were dredged in the Zoological Gardens.

It is stated by Pallary to occur in the waters of the Nile and in the canals of the Delta.

UNIONIDÆ.

Nodularia nilotica, Cailliaud, 1823.

Frequent in mud from ponds in the Zoological Gardens and from the Ismailia Canal.

FIG. 84.—*Nodularia nilotica*. (× 1.)

Pallary states that this species is rarely found in typical form, but it occurs throughout the course of the Nile.

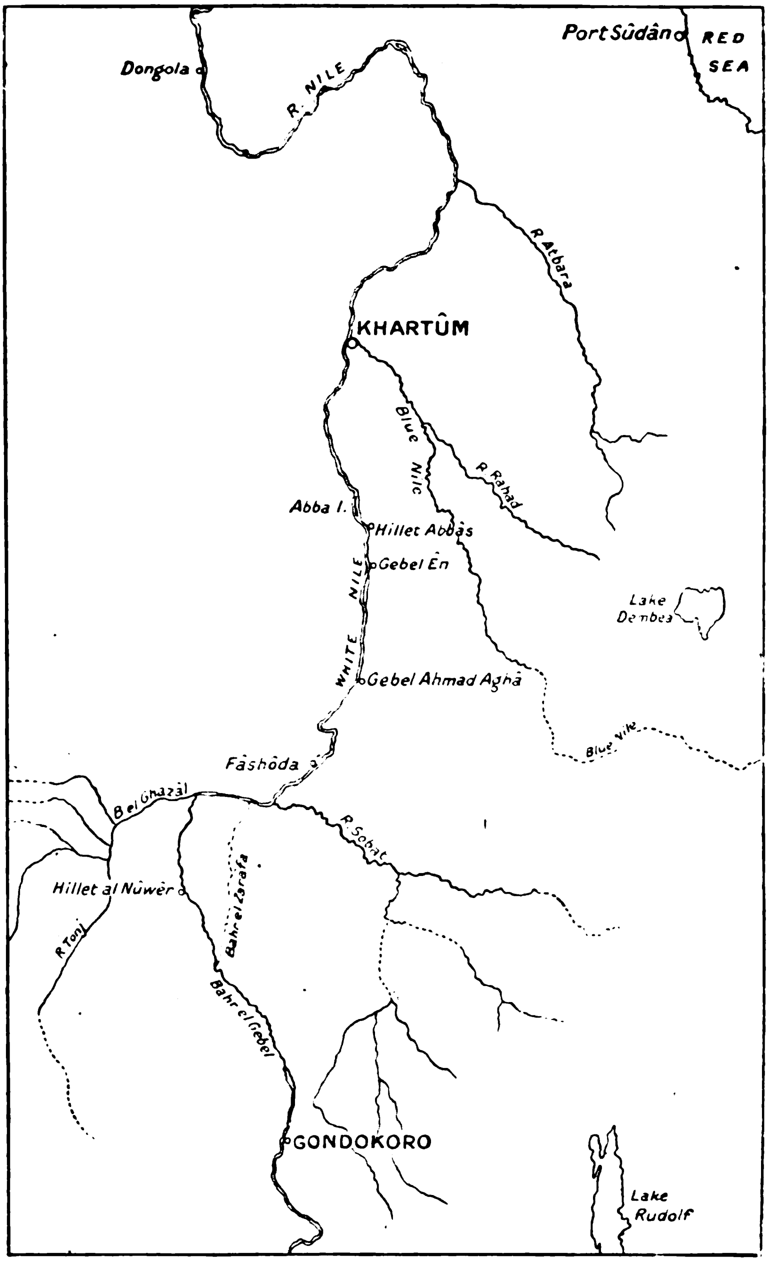

FIG. 85.—Distribution of *Planorbis boissyi* in the Sudan.

ACKNOWLEDGMENTS.

The present section completes the account of the investigations in the field. These extended from February until July of 1915, and were continued, under the auspices of the Wandsworth Trust, from November until February of the present year. Throughout the whole period of my mission I enjoyed the full use of the laboratories of the Department of Biology and Parasitology in the Government School of Medicine, Cairo. I now desire to put on record my deep sense of gratitude to the school authorities, and particularly to the director, Dr. H. P. Keatinge, who took a keen personal interest in the progress of the inquiry. I was also indebted in the earlier stages to Dr. A. R. Ferguson, Professor of Pathology, and later to Dr. W. H. Wilson, Professor of Physiology, for their kind and helpful advice.

At various times I had to seek official information and expert opinion, which was always most cordially given, from a number of other Government departments in Egypt. Dr. Charles Todd, chief of the Bacteriological Institute; Mr. E. Hurst, of the Physical Science Department; Messrs. Lucas and Pollard, of the Chemical Laboratory; Mr. J. I. Craig, of the Statistical Department; Major Flower and Messrs. Nicoll and Bonhote, of the Zoological Service; Mr. Branch, Secretary of the Sultanieh Society of Agriculture; Mr. Adamson, chief of the First Irrigation Circle; and Mr. W. A. Maule, of the Egyptian Government Survey, are amongst those to whom I am especially indebted for help on particular aspects of the Bilharzia problem, as it presented itself in Egypt.

I take also the opportunity which presents itself here to acknowledge my obligations for the valuable help received from Drs. Cockin and Thomson. Dr. Cockin unfortunately met with an accident early in March, and was invalided home. Dr. J. Gordon Thomson devoted himself with single-minded energy to the laborious work of collecting and prosecting, and although he personally wished to join for general service in the Royal Army Medical Corps in May, he was good enough to remain with me until the beginning of July. A considerable number of the molluscs, figured in the present section, and of the cercariæ listed, were accumulated through his labours. It was in one of his dissections that the cercaria of the *Bilharzia mansoni* was first recognized.

I have pleasure, too, in bringing under notice the valuable services given by W. McDonald throughout the whole year's work both in the field and in the laboratory. I have no hesitation in saying that it was mainly due to his sustained application and persistent loyalty in following out my instructions that the cercaria of

TABLE OF EGYPTIAN MOLLUSCS IN WHICH TREMATODE LARVÆ OCCUR.

Cercaria group / Host	Planorbis: Menetus	Planorbis: Gyraulus	Bullinus	Pyrgophysa	Physa	Limnæa	Vivipara	Cleopatra	Lanistes	Bythinia	Melania
(*A*) Gasterostome ..	..	..	..	..	..	..	..	..	..	..	..
(*B*) Monostome	..	..	..	..	..	C. sp. ?	..	..	..	..	*C. verrucosi*
(*C*) Amphistome	..	..	*C. pigmentata*	*C. pigmentata*	..	..	..	*C. ægyptiaci*	..	..	..
(*D*) Lophocerca ..	..	..	..	..	..	..	..	*C. cristata*	..	C. sp. ?	*C. microcristata*
(*E*) Distome—											
(1) Cystocercous ..	..	..	..	..	..	..	..	*C. capsularia*	..	..	..
(2) Rhopalocercous ..	..	..	..	..	..	..	..	..	..	..	..
(3) Leptocercous—											
(*a*) Gymnocephalous	..	..	C. sp. ?	..	C. sp. ?	*C. obscura?*	..	*C. distomatosa*	C. sp. ?	..	..
(*b*) Echinostome	C. sp. ?	..	*C. agilis*	..	..	..	..	..	..	C. sp. ?	..
(*c*) Xiphidiocercaria	..	..	..	..	..	C. sp. ?	*C. pusilla*	*C. exigua*	..	..	*C. cellulosa*
								C. microcotyla			*C. microcotyla*
(4) Trichocercous ..	..	..	..	..	..	..	..	..	..	..	..
(5) Cercariææ ..	..	..	..	..	..	..	..	..	..	..	..
(6) Rattenkönig-cercariæ	..	..	..	..	..	..	..	..	..	..	..
(7) Microcercous ..	..	..	..	..	..	..	..	..	..	..	..
(8) Furcocercous ..	..	..	..	..	..	..	..	*C. vivax*	..	..	..
	..	*C. fissicauda*	*C. fissicauda*	..	..	..	..	..	..	..	*C. bilharziella*
	C. bilharzia mansoni	..	*C. bilharzia hæmatobium*	..	..	..	..	..	..	C. sp. ?	..
	C. bilharziella	*C. bilharziella*									

Bilharzia hæmatobium was discovered. The sections showing the cercariæ entering the skin and some of the illustrations in this report testify to his technical skill.

Addendum to Part II: on Army Prophylaxis.

Water Filtration

In the spring of 1916 further experiments were made at the request of Surgeon-General Sir W. Babtie to determine the degree of protection afforded by a modified Jewell system of filtration which it was proposed to instal at various points on the Sweet-water Canal. This system consists in the addition of alum in a settling tank prior to filtration through sand about a metre in depth, and provides for six possible traps for the *Bilharzia cercariæ* during the passage from the source to the consumer, viz.:—

(*a*) In the settling tank ..	(1) Time factor.
	(2) Exposure to oxygen.
	(3) Chemical action of alum.
	(4) Arrest from entanglement in the flocculent precipitate.
(*b*) In the filter	(5) Arrest on the surface by the "vital layer."
	(6) Arrest due to depth of sand.

A working model was kindly supplied by Mr. McCroquidale, manager of the Cairo Waterworks, and the rate of flow, head of water and depth of sand were identical with those adopted for the field systems, the only difference being in the superficial area of filter and settling tank.

The following conclusions were formulated:—

(1) The *B. cercariæ* survive and remain actively swimming for a much longer period than the time (five to eight hours) that the water takes to pass through the settling tank.

(2) Oxygen has a stimulating effect on the cercariæ and is a necessity for their continued activity.

(3) Alum in the dilutions used for sedimentation of canal water has no effect on the *B. cercariæ.*

(4) The *B. cercariæ* are not entangled in the flocculent alum precipitate. They are seen swimming freely in the supernatant fluid twelve hours after the addition of the alum.

(5) The "vital" layer, formed by the deposition of alum on the surface of the sand and the arrest of bacteria and fungi therein, does not arrest the *B. cercariæ.* These were found to pass easily through the layer formed by the passage for half an hour of aluminized water taken from the settling tanks of the Cairo Waterworks. The same result followed in another test made by passing newly forming alum precipitate on a small area of sand for an hour, thus producing an abnormally thick layer. This too offered no

obstacle to the leech-like progression of the cercariæ, for they were found actively swimming in the filtrate twenty-four hours later.

(6) Finally, depth of sand presented no insuperable barrier, for very active cercariæ were found in the filtrate of our working model within one hour after their addition to the inflow of aluminized water, a depth of thirty inches of sand having been traversed in this interval. The sand was a sample of that ordinarily used by the Cairo Waterworks. Sand of the finest grain used in filtration was similarly tested and proved inefficient.

Mechanical systems of filtration, such as the Jewell system, depend therefore solely on the delay they interpose between the discharging mollusc and the consumer for the amount of protection they afford against bilharziosis. At Cairo the additional delay after the intake of water from the main stream of the Nile is about twelve hours, while at Ismailia under a different system the delay is about twenty-four hours. The uniform dispersal of the cercariæ in the filtered water has also to be borne in mind. The "time factor" in the life of the *B. cercariæ* apparently affords a satisfactory explanation of the relative immunity of Europeans in those Egyptian towns where there is both a filtered and raw water supply.

CHEMICAL STERILIZATION.

(*A*) Sodium bisulphate is used in "tabloid" form to sterilize water for drinking purposes. Two "tabloids" are dissolved in a quart water-bottle as a rule. Each "tabloid" contains 16 gr. (1 grm.). This gives a dilution of 1 in 567. A dilution of 1 in 1,000 is quickly lethal to the bilharzia cercaria. These "tabloids" may therefore be used with safety in bilharzia-infected countries.

(*B*) In view of its germicidal value, chlorine 1 in 1,000,000 acting for half an hour is in common use. This dilution would not have the requisite effect upon the activity of the bilharzia cercaria. It would be necessary to use two parts of available chlorine per 1,000,000, and afterwards to dechlorinate in order to render water taken from the canals and ditches in Egypt free from bilharzia infection.

For troops stationed on small outposts in the Delta safe water can be had, after two days, by improvising storage in tarpaulin sheets, etc. Where this is impossible the drinking water should be separated from ablution water and the former sterilized by boiling or by tablets of acid sulphate of soda. *The ablution water may be rendered quite safe for immediate use by the addition of ordinary Army "Cresol" in the dilution* 1 *in* 10,000, *while* 1 *in* 90,000 *is sufficient if the water is kept overnight.*

(*To be continued.*)

BERIBERI—WITH SPECIAL REFERENCE TO PROPHYLAXIS AND TREATMENT.

By Colonel WILLIAM HENRY WILLCOX, C.M.G., M.D., F.R.C.P.Lond.
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The following paper is based upon the careful clinical study of over fifty cases of beriberi seen during the latter half of the past year in the Mediterranean area.

The cases were of especial interest as regards their ætiology.

It is generally recognized that diet plays a very important part in the causation of beriberi, and some writers—e.g., Osler in the last edition of "The Principles and Practice of Medicine"—go so far as to definitely classify beriberi among such diseases as scurvy as a "deficiency disease."

In the cases seen many of them showed some other ætiological factor than that of diet; there was some toxic influence at work as well, such as a previous attack of dysentery, chronic diarrhœa, purpura, or jaundice.

Thus in cases in British troops from the Dardanelles area twenty-six cases of beriberi were seen. Of these twelve had recently, before the onset of symptoms, suffered from jaundice. One case suffered from paratyphoid A fever associated with slight jaundice. One suffered from a slight attack of jaundice three weeks after the onset of beriberi. Five cases had suffered from previous chronic diarrhœa or dysentery. Three cases had suffered from purpura.

In eleven cases of beriberi seen in British troops from the Mesopotamia district, one had suffered from recent jaundice previous to the attack, and one from chronic diarrhœa.

The dietetic conditions in the two series of cases previous to the onset of the disease were similar except that in the Mesopotamia series of cases, owing to difficulties unavoidable to an expedition of that nature, the dietetic factor undoubtedly played a more important part than in the Dardanelles cases.

Clinically and pathologically there is not the slightest doubt that all the above cases were typical cases of beriberi.

In the twenty-six Dardanelles cases twenty-one suffered from

some toxic factor associated with recent jaundice, diarrhœa, paratyphoid fever, or purpura, so that it is seen that there were very few cases in which diet was the only ætiological factor.

It must be remembered, however, that the diet on campaign given in hospital for diseases like epidemic jaundice, diarrhœa, dysentery, and paratyphoid fever, while being suitable for the treatment of these diseases, is nevertheless very deficient in anti-beriberi vitamines, and thus if one regards beriberi as due entirely to dietetic influences, these cases cannot be excluded as beriberi cases, since the diet associated with the treatment of the diseases in question might undoubtedly cause beriberi in a patient who, as regards his previous dietary, had only a small margin as regards his protection *quâ* diet against beriberi.

In the Mesopotamia cases the toxic factor was quite unimportant, and calls for no consideration, since the occurrence of toxic factors would undoubtedly have been as great amongst any other disease occurring in these troops.

SYMPTOMS.

In the cases observed, which were almost entirely of the œdematous or wet type, the earliest symptom noticed was usually some weakness of the legs or shortness of breath on exertion, generally accompanied by malaise and anorexia.

In a few cases the œdema of the legs was the first symptom observed, but it must be remembered that the detection of a preliminary symptom is dependent on the subjective observation and intelligence of a patient, and can only be elicited by means of "leading questions." Paræsthesia of the legs occurred quite early in some cases, patients complaining of numbness, "pins and needles" and alteration in the tactile sense. The weakness of the legs was shown by inability to march or walk properly, the gait being somewhat unsteady.

Probably one of the earliest evidences of weakness of the legs would be shown by the *squatting test*, which was quite too much for any of the patients in my series to perform at the time of examination.

The *squatting test* consists in the patient bending his knees and separating them while standing so that he assumes a squatting position with the buttocks a few inches from the ground. A beriberi patient is unable to raise himself up from this position, and often attempts to do so by climbing up his knees with his

hands very much like a patient suffering from pseudo-hypertrophic muscular atrophy.

This test should be remembered by regimental officers as a simple way of picking out early beriberi cases from amongst a body of troops who may be likely to be affected with the disease

One patient said that he first noticed that something was wrong because he could not step up on to the firing ledge of his trench. For a few days he was lifted up there by his comrades, and supported while he did his allotted task. He soon became too weak to walk and then became a hospital patient.

Dyspepsia was an early symptom in most of my cases; it was not of a severe type and consisted of epigastric discomfort and flatulence. There was commonly definite tenderness on palpation over the duodenum.

Swelling of the legs and feet was a marked symptom in many of the cases, and in some the œdema extended on to the thighs, scrotum and abdomen. In severe cases there may be œdema over the sternum.

In some cases the œdema was slight. It must be remembered that one important factor in causing the œdema is the standing position. In mild cases, after resting in bed and appropriate treatment, the œdema quickly clears up.

NERVOUS SYMPTOMS (PARÆSTHESIA HAS BEEN NOTED ABOVE).

Anæsthesia and analgesia occurred in all the cases; there was inability to distinguish on the feet and legs the difference between a pin-prick and finger-touch when the eyes were closed; the extent of this anæsthesia varied in different cases. In some cases the feet only were affected; in others the feet and legs; and in some cases the anæsthesia of the feet and legs was complete. In a few cases the upper extremities were affected. All cases showed definite weakness of the legs, and marked wasting occurred in all. The extensor muscles were affected more than the flexors, so that foot and ankle drop were present in cases showing severe nervous symptoms. There was not opportunity to test the electrical reactions of the affected muscles.

Tenderness of the calves on pressure was present in all the cases. In some cases cramp in the calves occurred.

Gait.—This was unsteady in type and there was a tendency for the toes to drop and render walking difficult; the gait was

somewhat high-stepping in type in some cases. The gait had not the stamping character characteristic of tabes dorsalis.

Some cases—e.g., two out of the twenty-six Dardanelles cases—showed definite *circumoral anæsthesia.*

Laryngeal paresis occurred in two of the twenty-six Dardanelles cases, and in two of the eleven Mesopotamia cases there was loss of voice for some days.

Pharyngeal paresis, shown by difficulty in swallowing, especially marked for liquids, occurred in one of the Mesopotamia cases and in one of the Dardanelles cases.

Reflexes.—The knee-jerks may be increased in the first few days. They are soon, however, diminished, and become quite lost, even with reinforcement by pulling the hands apart, the fingers being opposed.

An interesting symptom often present in beriberi cases is that the knee-jerk disappears before the Achilles jerk, and when both reflexes are lost the Achilles jerk is recovered before the knee-jerk when the patient improves. This sign occurred in several of the cases of each series. It was first pointed out to me by Lieut.-Col. de Crespigny of No. 3 Australian Hospital. I do not believe that it has been previously published.

Late signs in some of the cases showing severe multiple neuritis may be *contractures* of the muscles, e.g., those of the calf causing a condition of talipes equinus ; these are not common.

Cardio-vascular Symptoms.

The pulse is usually quickened, especially on exertion. In severe cases it may be feeble and irregular. Palpitation is a common symptom. The cardiac dulness is increased, both on the right and left sides. The heart shows signs of myocardial degeneration. The impulse is feeble, and the first sound of the heart is short and poor in quality. Often a systolic murmur replaces the first sound of the heart more or less completely. There may be a definite galloping rhythm in severe cases. Mild cases may show reduplication of the second sound of the heart.

In the twenty-six Dardanelles cases, twelve showed signs of marked cardiac involvement. In four of the cases the cardiac symptoms were of a very severe type, there being marked dilatation, irregularity and galloping rhythm.

Pyrexia is absent in beriberi cases, unless they are associated with intercurrent affections.

Vomiting occurred in a few cases; it is a bad sign and many of the cases terminate fatally.

Loss of weight was marked in most of the cases.

Types of Beriberi

other than the œdematous type described above are:—

(1) *The Acute Pernicious Type.*—In this type sudden death, without previous complaint of illness, may occur and the post-mortem examination show signs of beriberi.

Usually anorexia, nausea, vomiting, epigastric discomfort and tenderness occur first, and these are quickly followed by marked cardiac symptoms. Dropsy usually occurs, and also some signs of neuritis such as anæsthesia, hyperæsthesia, paresis, or paralysis. The patient dies of severe cardiac symptoms within a few days.

(2) *The Dry or Atrophic Form of Beriberi.*—This is similar in its symptoms to the œdematous type, except that dropsy is absent. Marked wasting is a prominent feature. One of the Dardanelles cases was of this type.

(3) *The Rudimentary Form.*—In this type the symptoms are slight. The patient complains of malaise, dyspepsia with paræsthesia and anæsthesia of the lower extremities, and some loss of power. The symptoms rapidly clear up under appropriate treatment.

Post-mortem Signs.

Three of the Dardanelles cases died. Careful post-mortem examinations were made on two of them.

The following were the special post-mortem signs found in these two cases:—

Very marked œdema of the lower extremities, and to a slight extent on the trunk and upper extremities.

The stomach showed marked redness of the mucous membrane, which was most marked in the pyloric half, where the colour was deep crimson.

The duodenum showed intense crimson congestion of the mucosa, most marked in the upper part.

The jejunum and ileum showed marked congestion, some petechiæ being present in the ileum.

The large intestine showed congestion.

Numerous small hæmorrhagic patches about half an inch in diameter were present in the wall of the ascending colon.

The mesenteric glands showed slight enlargement.

The heart showed marked dilatation of the right and left cavities. No valvular disease was present.

The lungs showed œdema and congestion of bases.

The kidneys were congested and showed some œdema.

The liver was congested and showed slight nutmeg change.

The popliteal nerves were removed for subsequent examination for degenerative changes.

Ætiology.

The ætiology of beriberi is one of the most interesting problems in medicine. A great deal of original work has been done on this disease during the last twenty years, and the important work recently done by Funk, Fraser, Stanton, Eykman and Cooper have definitely established the important fact that beriberi is essentially a deficiency disease.

Gowland Hopkins in his recent studies of the important part played by vitamines in metabolism has confirmed the conclusions of the above-mentioned investigators.

Modern research on metabolism has shown that a diet of pure protein, fats, and carbohydrates, with due admixtures of salts and water, is not sufficient to maintain health, though the quantities given may be theoretically correct.

A growing animal fed on the above dietary will cease to grow and will develop some deficiency disease, such as polyneuritis (beriberi) or scurvy. Some other addition is necessary in the dietary if the animal is to maintain health and thrive. Many natural foods contain the necessary additional substances, and these additional substances need only be present in most minute amount in order to make a diet which was formerly deficient quite ample for growth and health. The necessary additional substances are known by the name of *vitamines*.

The *vitamine* for preventing beriberi, or polyneuritis in animals, is different from that which prevents scurvy.

The anti-beriberi vitamine is a nitrogenous substance. It is not a protein. It does not contain phosphorus. It is soluble in water and alcohol or dilute acids. It is destroyed on heating to 130° C., but not at a temperature of 100° C., nor by dilute acids, though sterilization of foods undoubtedly destroys the vitamine.

Tinned foods, owing to the heat employed in their sterilization, are almost entirely deficient in anti-beriberi vitamine. The anti-beriberi vitamine is more stable than the anti-scurvy vitamine. Thus the latter is destroyed by heating to temperatures below

100° C., e.g., about 70° C. Also the drying of fresh vegetables, or even the keeping of them for long periods, destroys the anti-scorbutic vitamine.

Rice has long been associated with the causation of beriberi, and modern research has completely cleared up the former obscurity as regards its relationship. The rice grain consists of a husk or pericarp, beneath which is a subpericarpial layer or aleurone layer, and the main central part of the grain or endosperm consists chiefly of starchy matter. The anti-beriberi vitamine is present in the subpericarpial or aleurone layer. Machine-polished rice consists solely of the starchy endosperm, the pericarp and subpericarpial or aleurone layer being completely removed. This rice, which is the ordinary white rice of commerce, is devoid of anti-beriberi vitamine and birds fed on it rapidly develop polyneuritis, which will prove fatal.

Human beings fed on this rice will develop beriberi if it is the main article of diet, and if the other articles of diet are deficient in anti-beriberi vitamines.

Rice from which the husk is removed by steaming or treatment with hot water (parboiled rice) and subsequent rubbing in a mortar or by hand, will not cause beriberi. The reason is that some of the subpericarpial layer, or aleurone layer, is left adherent to the grain and this contains the anti-beriberi vitamine which is so essential to the dietary.

Numbers of experiments on animals and observations on human beings who have contracted beriberi from rice have completely proved the above view.

In animals in whom polyneuritis or beriberi has been caused by feeding on polished rice, the symptoms quickly clear up if for the polished rice the native unhusked rice, i.e., the rice from which the husk has been removed by previous treatment with steam or hot water, is substituted. Instead of this the addition to the polished rice of an extract of the husks of rice will have the same beneficial effect.

The Katjang idjoe bean also contains anti-beriberi vitamine and its addition in amount of $\frac{1}{3}$ pound a day to a polished rice diet will prevent beriberi in natives.

Yeast is a substance which is, perhaps, the richest in anti-beriberi vitamine. Egg-yolk, brain, liver, kidneys, sweetbread, oatmeal, haricot beans, peas, are all fairly rich in this vitamine. Milk and fresh meat contain only small amounts.

In the cases of beriberi in this series the dietetic conditions were compatible with the development of beriberi.

In the Dardanelles series the presence of a toxic factor such as jaundice, diarrhœa, or paratyphoid, necessitated a special diet, which, though suitable to the diseases in question, was almost devoid of anti-beriberi vitamine, and so an additional dietetic factor was added to a borderland case, thus causing the development of beriberi.

Other causes of beriberi which have been stated by various authorities are the following :—

(1) Arsenical poisoning.

(2) Copper poisoning.

(3) Poisoning by potassium oxalate.

(4) *Food poisoning*, e.g., raw fish containing parasites, decomposed fish, or decomposed rice.

(5) Bacterial infections, e.g., a specific coccus, the Kakke coccus of Okata and Kokubo, two Japanese surgeons. Other organisms have also been described by different observers.

(6) That it is due to animal parasites, e.g., *Ankylostomum duodenale*, or *Trichocephalus dispar.*

(7) That it is due to a fungus, e.g., Captain Archibald in one case has isolated a spore-bearing fungus from the intestine, liver, and spleen.

(8) That it is a disease of locality, the infection being spread from the soil.

(9) That it is due to a deficiency of *organic phosphorus* in the dietary.

The subpericarpial or aleurone layer of rice is richer in organic phosphorus than the endosperm, and as a consequence it was found that rice poor in phosphorus was more likely to cause beriberi.

The investigations into the nature of the anti-beriberi vitamine by Funk and Cooper showed that it contained no phosphorus, and that the addition of organic phosphorus compounds did not *per se* have any curative or prophylactic effects in animals suffering from polyneuritis caused by a diet deficient in anti-beriberi vitamines.

It cannot be said that any of the above have been definitely established as causes of the disease.

Certain is it that the "deficiency theory" has been proved to be the most important factor. It is possible that infective causes such as microbic or fungoid may also play a part.

Predisposing causes are undoubtedly bad sanitary conditions, an insufficient and poor quality diet, previous debilitating diseases, such as dysentery, jaundice, etc.

Geographical Distribution.—Beriberi is usually regarded as a

tropical disease, since it occurs in Japan, China, Malay, the Philippines, India, etc. Outbreaks have, however, occurred in America, and in asylums in England and Ireland. It is undoubtedly rather the dietetic conditions associated with a particular place than the place itself which is the important factor.

Differential Diagnosis.

Scurvy.—This is often present in association with beriberi, especially in cases such as those occurring on board ship, or on campaign, where there is difficulty in the supply of fresh food. In the Dardanelles series of beriberi cases, three showed scorbutic symptoms, e.g., purpura, though they could not be said to have scurvy.

In scurvy important diagnostic signs are: The purple swollen gums with tendency to bleed; purpuric patches on the skin; anæmia; hæmorrhage into the hard palate; tenderness and swelling of bones due to subperiosteal hæmorrhage. This condition is most often evident in the tibiæ, and then there is a good deal of firm œdema of the skin around the affected bone. Indeed swelling of the legs may be very marked, but there is great local tenderness over the tibiæ, and not in the calves.

The above signs clearly distinguish scurvy from beriberi. In scurvy also multiple neuritis is absent.

The effect of treatment often serves to distinguish the two diseases. Thus, while scurvy rapidly clears up if special anti-scorbutic substances, such as raw potato, lemons, and fresh vegetables (uncooked), are given, beriberi requires a special dietary of a different nature, as described below.

Multiple neuritis from other causes, such as alcohol, diphtheria, arsenical poisoning, etc., must be carefully distinguished from beriberi. The history of the case and other evidences of the action of the toxic agent, e.g., cirrhosis of liver from alcohol, pigmentation and rashes and presence of arsenic in the urine or hair in arsenical neuritis, will usually enable a differentiation from beriberi to be possible.

Diseases of the spinal cord, such as tabes dorsalis, myelitis, scleroses of various kinds, may be mistaken for the neuritis of beriberi. A careful examination for such symptoms as lack of bladder control, extensor plantar reflex, or ankle clonus, distinguishes myelitis and sclerotic conditions of the cord from beriberi.

In tabes, the Argyll-Robertson pupil, the marked ataxy, the absence of muscular wasting or tenderness of the calves, are signs distinctive from beriberi.

Dropsy from other causes, such as:—

Renal disease, where the presence of albumin and casts in the urine and absence of neuritis are points of distinction.

Cardiac disease, where the history of the case, e.g., previous rheumatism or syphilis, or other cause of valvular disease, the long duration of the cardiac symptoms without signs of multiple neuritis, and the physical signs of actual valvular disease make the distinction from beriberi easy.

Epidemic dropsy is characterized by pyrexia, anæmia and absence of multiple neuritis, which serve to distinguish it from beriberi.

Treatment.

Absolute rest in bed is essential in the early stages and in all cases showing cardiac symptoms.

Diet.

In an acute case, where gastric symptoms are marked, the diet will necessarily be light and mainly liquid.

Yeast should be given. Two ounces of dried yeast, such as is supplied on campaign under the name of export yeast, should be given daily. This is conveniently given by pouring on the yeast a little boiling milk, stirring up into a thin cream, and then adding more warm milk and sugar, so that a palatable food results.

In place of export yeast, cakes of dried yeast mixed with a little starch are often available. These are supplied under the name of "Royal Yeast Cakes," which are like small biscuits weighing about half an ounce each. Six of these should be given daily. The following was found a convenient and palatable method of preparing the yeast cakes for consumption. One or two yeast cakes were placed in a basin, boiling milk was poured on them, and the cakes broken up and rubbed round with a spoon into a thin cream. Then warm milk and sugar were added, and the mixture was then ready for taking.

If neither of the above forms of yeast are available on campaign, yeast can always be obtained from the Army bakeries, where yeast brews are constantly kept going. The yeast obtained here will be mixed with the liquid of the brew. About half a pint of this should be taken daily. It may be sweetened with sugar and flavoured with lemon rind or essence of lemon. It is quite palatable.

Pea soup is a useful article of diet, the pea powder containing anti-beriberi vitamines.

Three or four raw eggs should be given daily, beaten up with milk, or taken in any other way.

The above dietary is rich in anti-beriberi vitamines, but a valuable addition to it will be fresh lemon juice, e.g., the juice of two or three lemons per day. This will contain anti-scorbutic vitamines, which are often needed by beriberi cases, owing to the close association ætiologically between beriberi and scurvy.

When the patient can take solid food in addition to the yeast, which is very essential throughout the disease, the following articles of diet may be given. They are arranged in order as regards their value from the quantity of essential vitamine present; those highest in the list being richest in vitamine.

Yeast (already mentioned): eggs, either raw or lightly cooked; brain, liver, sweetbread, kidneys, heart muscle, peas, haricot beans, Katjang idjoe beans, lentils, porridge, brown bread, milk (fresh if possible); fish or meat, ordinary bread or biscuits, lemon-juice or lime-juice should also be given.

Extracts of yeast are on the market. These taste exactly like extract of meat, and when mixed with warm water form a drink like ordinary meat extract or bovril.

Yeast extracts may be given with advantage in beriberi cases, both acute and chronic.

The relationship of rice to beriberi has been fully dealt with, and rice is best avoided in the treatment of beriberi cases.

Fresh vegetables, fruit and, generally speaking, an ample dietary should be given in beriberi cases where there is no gastric disturbance.

The symptoms of beriberi call for special treatment, thus:—

The cardiac symptoms will require treatment by means of cardiac tonics, e.g., digitalis, strychnine, strophanthus, etc.

In severe cases strychnine and digitalin may be given hypodermically; and oxygen. Oxygen passed through absolute alcohol is valuable.

The multiple neuritis calls for treatment on the usual lines. Light massage, electric treatment by the galvanic current, etc., are valuable.

Prophylaxis.

Diet is most important. On campaign it is often difficult to avoid some deficiency in those articles of diet which are especially rich in anti-beriberi vitamines. Haricot-beans, pea-powder given in pea-soup, and porridge, are valuable and convenient articles of

an army dietary in the field. Fresh vegetables are also important.

If beriberi is prevalent, undoubtedly some preparation of yeast should form a constituent of the dietary of men exposed to danger from this disease. Dried yeast, or yeast cakes may be given, or else the yeast extract taken with hot water should be issued.

It is very important that beriberi cases should be recognized as early as possible, and this can immediately be done by the application of the "squatting test," described above.

Cases showing the early symptoms of beriberi should at once be put upon special treatment, since in the early stages the disease is easily and quickly cured.

General sanitary measures and attention to personal hygiene are of importance in the prevention of beriberi.

My especial thanks are due to Major Martin, R.A.M.C., of No. 3 Australian General Hospital, for valuable help and advice given in connexion with the beriberi cases. Much of the recent original work on beriberi was done under Major Martin's supervision at the Lister Institute, London, and the details given in this paper as regards diet are largely due to the valuable advice given by him.

I am also indebted to Lieut.-Colonel Stawell, R.A.M.C, and Lieut.-Colonel de Crespigny, R.A.M.C., of No. 3 Australian General Hospital, for their valuable co-operation and help in the clinical investigation of the cases.

My thanks are due to Colonel F. I. Brown, Senior Medical Officer, of H.M.H.S. "Mauretania," who very kindly placed at my disposal the cases of beriberi on his ship.

THE RATE OF MORTALITY IN THE BRITISH ARMY ONE HUNDRED YEARS AGO.

By ARNOLD CHAPLIN, M.D., F.R.C.P.

About two years ago my attention was drawn to this subject on account of the apparent absence of any reliable data on which a comparison could be based between the mortality in the British Army of the present day and that which took place before the dawn of the era of improved hygienic conditions. Since then my efforts have been directed to this subject, and it is hoped that the results will be found interesting enough to be made public.

The labour involved in collecting these statistics will not have been altogether in vain, if it be admitted that the exact measure of the advance in sanitary science can hardly be appreciated unless we possess some knowledge of the conditions existing in years long since gone. From the standpoint of history, however, there can be no doubt concerning the importance of this subject, particularly at the present time, for, while to-day our Nation is fighting and dying for its existence, it is a satisfaction to know that our forefathers cheerfully submitted to a heavy blood-tax, even in times of peace, in order to acquire and hold this mighty realm.

The literature of this subject is somewhat scanty, and few investigators appear to have been attracted to this question. The first serious attempt at estimating the rate of mortality in the Army was made by Colonel Tulloch and Assistant-Surgeon Balfour in their report to Parliament in 1838. In this admirable report they dealt with the mortality between the years 1816-36, and since they were accomplished medical men, their work has an added value on account of the light they throw on the causation of sickness and death. With the exceptions of Sir John Pringle, Sir Gilbert Blane and Dr. John Davy, Tulloch and Balfour were the first to draw attention to this subject from a statistical standpoint. The only criticism that can be advanced concerning their work is that, in some instances, they offer for comparison the mortality results of two or three years only, with those extending over twenty years. But Tulloch and Balfour could never have produced their valuable report had not the material been carefully collected under the able superintendence of the Medical Inspector-General of the Army, Sir James McGrigor. Indeed, it is due to him alone that we possess such a complete series of statistics bearing on the mortality in the Army.

The subject of mortality in the British Army has also been dealt with in a most able and comprehensive manner by actuaries. Messrs. Ackland, Smee, and James McLauchlan have communicated papers to the *Journal of the Institute of Actuaries* (vol. xxxiv), but the years investigated belong to a much later period than those under review in the present paper. In 1857, W. B. Hodge published in the same journal (vol. ii) a series of papers concerning the mortality in the Army during the Napoleonic and Crimean Wars, which exhibit a profound and wide acquaintance with the historical side of the subject, in addition to consummate statistical ability. Of course, the work of famous actuaries in this field is far above the criticism of a mere layman, still if one may be permitted, one would say, after a perusal of these papers, that, with the exception of those by Hodge, they fail somewhat on account of insufficient knowledge on the part of their authors of historical facts and hygienic conditions.

In pursuit of this investigation of the rate of mortality in the British Army one hundred years ago, I have taken a series of five years, from 1817 to 1821 inclusive. These years have been adopted for two reasons. Firstly, because they represent a period when the Empire was at peace, and therefore the results will be less likely to be vitiated by deaths from disease and exhaustion which always swell the death-rate after prolonged campaigns. Secondly, because that period may be fairly claimed to embrace the last few years antecedent to the dawn of modern clinical methods and all that they entailed. Deaths caused as the result of battles have been excluded, and the returns, therefore, represent the rate of mortality from disease alone. In order also to arrive at the death-rate in the Army under the most unfavourable sanitary conditions, I have investigated the returns relating to the rank and file alone. Deaths occurring amongst officers have been excluded. Finally, the figures include not only troops in the British Isles, but also those quartered in the British Possessions all over the world. It has been possible, therefore, to arrive at a comparatively comprehensive estimate of the rate of mortality throughout the British Empire one hundred years ago.

The documents consulted are to be found in the "War Office" series of the Archives in the Public Record Office, and among them of chief importance are: (1) "The Monthly Returns," W.O. 17, which give full information concerning the "Strength" and deaths per mensem occurring in the British Army; (2) "The Casualty Returns," which often furnish more precise details concerning the

deaths of soldiers; (3) "The Muster Rolls of Regiments," which give the numbers of sick in each month. Of the value, the extent, and the accuracy of these records it is impossible to speak too highly, and probably no nation possesses such a well-arranged and complete set of papers as exists in the "War Office" series in the Record Office. The "Archives Nationales" at Paris may, in certain particulars, claim precedence, but it may be doubted whether anything can approach the "War Office" series in completeness and system. Indeed, it is no exaggeration to assert that if the name and regiment of any humble soldier serving his King from 1750 to the present time be given, his whole record while in the Army can be traced by reference to this series. The "Casualty Returns" are also of considerable value, for they contain the wills of those who died while serving, and they give the place and nature of death. These wills are not without pathetic interest, written as they are on faded pieces of paper, in far-off lands. Most of them begin with the stereotyped formula, "In the name of God, Amen, I John Jones being about to meet my maker," and then follow simple directions as to the disposal of the small effects, such as a belt or a pocket-knife. Often, attached to the will is a scrawled and soiled document, in which the wife or other heir of the deceased acknowledges the receipt of, it may be, three-and-fourpence, the value of the effects, and thus the accounts of a humble but worthy maker of Empire are finally settled.

But however great the value that must be attached to the War Office Records, in one important respect they lack completeness. There are no documents which deal with the diseases which caused the mortality. Practically nothing is given concerning the incidence of disease, nor of the causes and symptoms. Epidemics frequently attacked regiments, and swept off hundreds, but one may search in vain in these records for such information. We can appeal, therefore, only to figures, and the actual deaths they represent, when we state the rate of mortality in the British Army one hundred years ago.

Even with these bare figures before us, the tale they unfold is, in many respects, surprising. Last July we were told that, as a result of one year's fighting in defence of our liberties, we had to mourn the loss of 60,000 brave men, out of a total of certainly not less than one million engaged, or in other words, our losses in killed had amounted to 60 per thousand. I do not, of course, contend that the whole of the million had been exposed to the risk of death in battle for a whole year, but the illustration will serve. Terrible,

however, as the slaughter has been, it is not worse than the havoc wrought by disease in the British regiments quartered in various parts of the Empire one hundred years ago when no fighting took place. Verily in a sinister sense it may be said that "peace hath her victories." This statement, that the rate of mortality of 60 per thousand in the present War is not worse than that produced by the ravages by disease a century ago will not be considered an exaggeration when I state that the average annual death-rate in white troops quartered in Jamaica was 185 per thousand, in West Africa 360 per thousand, and in India 87 per thousand. Let us, therefore, draw what poor comfort we can from the remembrance of the fact that, however much we may deplore the wastage of valuable life at the present time, our forefathers were called upon to bear an equal blood-tax in disease alone.

It is by statistical comparisons alone that an estimate can be made of the advances that have taken place in the domains of medical and sanitary science in the British Army, and the primary object is to show how enormous those advances have been. A hundred years ago disease was the all-powerful enemy; now the position is reversed, and disease no longer plays a prominent part in the conditions which control the activities of a striking force. At the present time death-dealing weapons have usurped the position of disease, and by their agency fighting forces are weakened and destroyed. What were the chief causes responsible for the heavy mortality from disease in the Army a hundred years ago? They may be generalized under three headings: (1) Ignorance of the causation of disease; (2) neglect of the study of conditions necessary for health; and (3) improper clothing and food of the Army in various conditions of climate. To these a fourth factor may be added, viz., the mortality which occurred as the result of being admitted to the military hospitals. Many writers have adverted to this, and strange as it may seem, the risk of the death of a patient was largely enhanced by removing him to the wretched hovels which did duty as hospitals. Almost invariably the disease took a serious turn, and if death did not ensue from the original complaint, the military hospital contained sufficient infection to implant another fatal disease in its place. In tropical climates, soldiers encumbered by their accoutrements and heavy uniforms undertook long marches in the burning sun, and at the end of their journey were allowed to slake their thirst with copious draughts of strong ale. The food they consumed was ill suited to the work they had to perform, and the climates in which they lived.

At home, typhus fever and small-pox were liable to break out at any time, and to decimate a regiment. Chest complaints and venereal diseases were very prevalent, and, from officer down to private, insobriety was rampant. Abroad, in the Tropics, the troops suffered from frequent outbreaks of malaria, plague, yellow fever, and cholera, and for want of proper headgear sunstroke was common. One has only to read the memoirs and autobiographies of officers and surgeons of those days to understand the terrible havoc made by these diseases.

Having now explained the design of this investigation, and the disadvantageous conditions which were responsible for the high death-rate in the Army one hundred years ago, attention may be drawn to some of the most important features which come to light from a survey of the mortality in the various quarters of the world in which the troops were stationed. In the first place, however, it will be necessary to establish as an index the rate of mortality in the Army while quartered at home. For this purpose the returns of the troops stationed in Scotland, and those of the Foot Guards on service in London, have been used. From these two sources of information it is found that the annual rate of mortality from 1817 to 1821 was 15 per thousand in the case of troops in Scotland, and 19 per thousand in the case of the Foot Guards in London. These figures may be regarded as the two extremes so far as Great Britain is concerned, and no great error will be committed in stating that about seventeen soldiers out of every thousand quartered in Great Britain died each year from 1817 to 1821. One would have supposed that this rate of mortality of 17 per thousand, occurring in a picked class of men, would compare favourably with that of the rest of the male population of the same ages and subjected to selection. But this is not the case, for Ansell's tables of the mortality among members of the friendly societies during the years 1823 to 1827 show that the mean rate of mortality between the ages of 20 and 40 was 11 per thousand, a rate very much better than that of the Army.

Having, therefore, established the death-rate in the Army under "Home" conditions at 17 per thousand, we may now consider how that death-rate varied in the diverse climates of the Dependencies of the British Empire. Before proceeding to that subject, however, it may be stated that the death-rate in the Army in Great Britain has fallen from 17 per thousand in 1817 to 1821 to 2·6 per thousand in 1907 to 1911, a truly wonderful achievement to place to the credit of sanitation. A hundred years ago, in every Colony

of the Empire, with the exceptions of Gibraltar, Canada, and the Cape, the death-rate in the Army was far higher than in Great Britain, and in some places the price paid in deaths may be described as appalling. But mortality alone was not always the cause of ineffectiveness in the ranks of the Army, for sickness of an incapacitating kind frequently broke out and destroyed its efficiency. A prominent case in point is the well-known and ill-fated Walcheren Expedition of 1809. The medical history of this undertaking, as unfolded in the returns in the Record Office, is probably the most striking illustration extant of the way in which sickness alone may literally "wipe out" an army of considerable size. The whole story of the Expedition reads more like a romance than a sober account of mortality and sickness. The Army was away for little more than three months, and comparatively little fighting took place, but the scene of its operations was laid in the swampy Islands of Walcheren and Beveland, in the mouth of the Scheldt. The health of the troops was excellent for a time, but early in September a miasmal fever seized upon the Army and wrought truly appalling havoc. In the middle of September it was decided to reduce the original force of 38,802 men to 16,386 by sending home twenty battalions, but the men composing them were so weak that they were incapable of marching. When, in November, after three months' occupation of this fever-stricken swamp, the poor remnants of the army were finally withdrawn, 5,671 only could be returned as effective and fit for marching. It was not death from the bullets of the enemy that caused these terrible ravages, nor was it even deaths from sickness, for during the three months that the Army remained in the mouth of the Scheldt 2,000 only died, though ultimately, of course, the mortality must have been severe. The medical arrangements at the outset were excellent, but disease soon swept off the medical staff, and it was not until Sir James McGrigor took charge that fair medical efficiency could be re-established.

In India the mortality among the British troops was very high a hundred years ago, the mean annual rate being about 87 per thousand, and it was not until about sixty years ago that an appreciable reduction could be shown in that rate. Since then, however, the rate has steadily diminished, until in the quinquennium 1907-11 it was the surprisingly low one of 6·7 per thousand. Few facts can attest more strongly the wonderful conquest sanitary science has obtained over the conditions militating against good health in the Tropics. Malaria, plague, cholera, dysentery, and the effects of the sun were responsible for this high death-rate one hundred years

ago, and although these agencies are still at work, the defence set up by increased knowledge and improved methods has rendered white troops practically immune from their attacks. Indeed, it may now almost be said that dysentery and enteric fever are the only two conditions which have a pronounced effect on the mortality of white troops in the Tropics.

The price paid by the British in blood to acquire, hold, and develop the Indian Empire has been a terribly heavy one; exactly how heavy can probably never be known. Ever since the days when Job Charnock, with his handful of followers, clambered up the steep mudbank on the Hugli, which was eventually to become Calcutta, the toll of human sacrifice and of British life is not to be computed in words. Not only have tens of thousands of British soldiers given their lives, but countless numbers of civilians have met early deaths in the struggle for British supremacy in India. The graves of these heroes, all ignorant of the great part they were playing, are to be found dotted all over the Indian Empire. But for the correct and complete registers of deaths in India kept at the India Office, and a curious and rare book entitled the "Bengal Obituary," published in 1851 by a firm of undertakers in Calcutta, in which the inscriptions found on tombstones in India are recorded, we should be ignorant of the price Britain has paid. In these records it is astonishing to observe the early age at which most of them died. Promotion and rank had to come to men early if it came at all.

West Africa, and particularly Sierra Leone, was fully entitled to the sinister appellation, "The White Man's Grave," for a hundred years ago the mortality, even in favourable years, was as high as 362 per thousand. In the five years from 1907 to 1911 the mortality had fallen to 11 per thousand, a truly marvellous result, and there are signs that future years will show still further improvement.

The various stations in the West Indies were all, more or less, unhealthy for British troops quartered there one hundred years ago. In the case of Jamaica, the mean annual mortality-rate was the enormous one of 185 per thousand, while in Bermuda, a comparatively healthy locality, it was 75 per thousand. The returns for the period 1907-1911 show the great improvement that has taken place, for in Jamaica the death-rate was 10 per thousand, and in Bermuda 3 per thousand. Throughout the West Indies yellow fever was very prevalent, and accounted for a considerable number of deaths. In addition, Jamaica manufactured large quantities of

rum, and the insobriety of the troops caused much illness. The most unhealthy season of the year in Jamaica was from September to January, and by far the largest number of deaths occurred during that period. The climate of the Island also proved to be very deadly to troops newly arrived, and in the case of the 50th Foot, no fewer than 248 died in the first ten months of residence out of a total strength of 513.

Malta was a healthy station when judged by the standards of those days, for the death-rate among the troops was only 25 per thousand. Canada and Gibraltar showed no variation from the death-rate obtaining in the United Kingdom, and the Cape was able to claim the lowest mortality rate of all, being only 12 per thousand.

It will be seen, therefore, that enormous advances have been made, during the last hundred years, in the science of military hygiene, and while, in the past, disease swept off far more soldiers than the accident of battle, now our method is so near perfection that death from disease is almost a negligible quantity. A perusal of the tables which accompany this article will give an idea of the advance that has been made.

In conclusion, it may be stated that the figures upon which this investigation has been based have been submitted to a distinguished actuary. He has looked through them, and has expressed the opinion that no statistical error has been committed.

A COMPARATIVE TABLE SHOWING THE MORTALITY PER 1,000 AT DIFFERENT PERIODS.

Place	1817-21	1876-85	1907-11
Great Britain	17	—	2·6
India	87	16	6·7
Gibraltar	18	7	3·4
Canada	19	5	—
Jamaica	185	16	9·9
Bermuda	75	7	2·9
Ceylon	111	14	7·4
The Cape	12	—	3·8
West Africa	362	—	11·9
Malta	25	—	2·8

A TABLE SHOWING THE MEAN ANNUAL STRENGTH, MEAN ANNUAL DEATHS, AND MEAN ANNUAL MORTALITY PER 1,000 IN THE BRITISH ARMY WHILE QUARTERED AT VARIOUS STATIONS, 1817-1821.

Station	Mean annual strength	Mean annual deaths	Mean annual mortality per 1,000
London	3,252	63	19 (approximately).
North Britain	3,040	47	15 ,,
Gibraltar	3,266	63	18 ,,
Malta ..	1,832	46	25 ,,
Ionian Islands	2,941	103	35 ,,
All India	18,195	1,591	87 ,,
Bengal ..	5,823	465	79 ,,
Madras	7,344	578	78 ,,
Bombay	2,874	279	97 ,,
Ceylon..	2,153	268	111 ,,
Jamacia	1,727	331	185 ,,
Bermuda	372	28	75 ,,
The Cape	2,113	26	12 ,,
West Africa	97	36	362 ,,
Canada	3,529	68	19 ,,
St. Helena	1,113	44	39 ,,

REFERENCES.

The volumes consulted in the Public Record Office are the "Monthly Returns" in the War Office, series 17 (W.O. 17), and the particular volumes referring to troops quartered in the various Dependencies are as follows:—

London	W.O. 17	Vols. 315, 335, 341, 349.
North Britain	,,	,, 1,047-51.
West Africa	,,	,, 1,169-71.
Bengal	,,	,, 1,324-8.
Bermuda	,,	,, 1,381-5.
Bombay	,,	,, 1,437-41.
The Cape	,,	,, 1,598 1602.
Canada	,,	,, 1,521-5.
Ceylon ..	,,	,, 1,656-60.
Gibraltar	,,	,, 1,803-7.
Jamaica	,,	,, 2,007-11.
Madras ..	,,	,, 2,068-72.
Walcheren	,,	,, 2,479.

SEVERE TETANOID SPASM LIMITED TO THE WOUNDED LIMB.

By Captain ARTHUR A. STRATON.
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The record here presented relates to one of a group of cases in which, following upon the receipt of a dirty and sloughing wound, there occurs a condition of continuous and long-continued spasm, associated with violent and tetanus-like contractions of extreme severity, but localized absolutely in distribution to the muscles of the part affected by the wound.

The patient, Pte. H., received on December 2, 1915, a shell wound in the right buttock. He was removed to a field ambulance where he received a dose of antitetanic serum, and thence to a clearing station, being detained in the latter until December 8 on account of abdominal pains and vomiting, suggesting intra-abdominal complications. On the latter date he was removed to the Base, and arrived at No. 11 General Hospital, Boulogne, in the early hours of December 9, 1915.

On arrival the patient was pale and collapsed, and obviously much exhausted by his journey; the temperature was 100·8° F., and the pulse 126, of low tension and somewhat thready. He complained of pain in the pelvis, and was much troubled with vomiting of a greenish bile-stained material. The abdomen was a little distended, but the walls of the abdomen were neither rigid nor tender; whilst from the suprapubic region a slight œdema and discoloration extended into either iliac fossa, suggestive of an extra-peritoneal hæmatoma.

On the right buttock, about 1½ inch below the crest, and the same distance external to the sacro-sciatic notch, was a round wound, about ½ inch in diameter, leading downwards and inwards, with sloughing edges, and exuding the thin, brownish, almost fæcal-smelling discharge that one associates with anaerobic wound infections. There was no true pus, and no marked œdema of the buttock. No sign of gas formation could be detected.

A skiagram showed a foreign body, in the form of a smallish piece of shell, lying in the pelvis in the mid-line, and situated at a depth of nine centimetres from the surface of the skin over the sacrum.

Course of the Disease.

From December 8 to 15 the patient gradually recovered from his vomiting and collapse; vomiting ceased on the 11th, and patient took plenty of nourishment from then onwards, but was a good deal troubled by pelvic pains. The wound was frequently irrigated with eusol, but remained somewhat malodorous, although there seemed to be no spread of the infection. The œdema and discoloration of the abdominal wall subsided; the temperature rarely rose above 100° F., whilst the pulse, varying between 108 and 80, became much improved in tone.

On December 15, however, thirteen days after the wound had been received, a new element appeared in the form of an occasional twitching of the muscles of the right thigh, both at the hip and at the knee, not at first very violent nor very frequent, but distinctly painful, especially in the upper and anterior parts of the thigh. During that night the condition became aggravated, restlessness increased and the movements became exaggerated and more painful, causing the patient to cry out.

On the morning of December 16 the whole of the right thigh was being thrown into a condition of spasm, during which the limb remained rigid, whilst violent contractions of the flexors of the hip-joint and the extensors of the knee took place. This general rigidity of the muscles of the thigh soon became continuous, so that the limb assumed a permanent condition of extension at both hip and knee, whilst at very frequent intervals a series of violent and exceedingly painful efforts at hip flexion would ensue, causing the patient to cry out in agony. A general impression given was rather that of a series of repeated and violent struggles around the hip-joint on the part of the flexors, battling against an overwhelming and progressively increasing force, attempting to impose upon the limb a state of continuous and laborious hyper-extension. The hamstrings and the quadriceps extensor were the muscles most involved in this condition of continuous spasm, though the sartorius, gracilis, adductors and glutei were all affected to a lesser extent, and enjoyed no interspasmal relaxation; in fact, this state of ceaseless muscular rigidity was actually to continue in the thigh for some weeks, and to terminate only in a very gradual relaxation. These flexors spasms were very frequent, and handling the part did not appear very greatly to aggravate the already grave condition.

The muscles of the leg and foot were not affected, nor were any other parts of the body involved in the spasms; there were never any signs of trismus nor of dysphagia.

In view of the probably tetanic nature of the convulsions, the patient was anæsthetized and antitetanic serum to the extent of three thousand units was administered intrathecally by lumbar puncture. The spasms, however, returned with equal intensity as soon as the effects of the anæsthetic had worn off, and morphia was then given in ¼-grain doses up to one grain.

On the following day (December 17) the spasms were more frequent, more violent, and more painful, the pain being situated mainly in the anterior muscles about the level of Scarpa's triangle. A further complication arose in the onset of a hæmorrhage from the wound necessitating operation. Under anæsthesia the wound was opened up and bleeding vessels in the glutei found and secured. The great sciatic nerve, being exposed, was found to be markedly purplish and bruised in appearance, but no gross injury could be detected. The bony edges of the sacro-sciatic notch were found to be broken, and loose portions of the spine and adjacent parts of the ischium were removed. The track into the pelvis was followed up, and the piece of shell lying in the hollow of the sacrum was removed from a cavity filled with clot and foul exudation. This cavity was then washed out with eusol and packed with gauze around a rubber catheter.

The spasms returned with consciousness, but patient was able to take plenty of food shortly after operation. Morphia was given in ¼-grain doses up to nearly three grains, whilst chloroform was administed during the worst spasms.

On the 18th and 19th the condition showed no improvement, and on the latter day, on account of the agonizing nature of the pain, a full intrathecal dose of stovaine was administered, without any satisfactory result ensuing, the spasms returning as soon as the effects of the chloroform given had worn off; that is to say, within less than one hour after the injection of the stovaine. A mixture of chloral and bromide was given, but the patient vomited after each dose and it was discontinued in favour of morphia, of which nearly three grains were given hypodermically on the 19th, and a full three grains on the 20th, whilst a slight chloroform anæsthesia was repeatedly induced both day and night.

At 3 a.m. on the 21st, the patient became suddenly much worse, the temperature rose from normal to 101° F.; the pulse flew up to 144, and the beat became feeble, irregular, and even intermittent. The colour became dusky, vomiting set in, and patient was in a highly critical condition. He rallied later, however, and the pulse improved during the day, though still maintaining its

irregularity. Large doses of morphia were given daily, combined with administration of chloroform, in spite of which the patient obtained very little real rest, sleeping but in snatches insufficient to compensate for the extreme exhaustion produced by the repeated very severe spasms, and aggravated by a troublesome vomiting which prevented him from obtaining sufficient nourishment. The position of the limb had been becoming more and more extended at the hip, until hyper-extension was now maintained, in spite of the violent attempts on the part of the anterior muscles to obtain flexion.

The vomiting began to subside on the 25th, and the patient was enabled to take more nourishment. Constipation was troublesome, partly due, in all probability, to the morhpia, the daily dose of which now averaged $2\frac{3}{4}$ grains.

On the 26th, the spasms began to lose some of their former violence and became rather less frequent; pain was still very great in the upper thigh muscles, and two grains of morphia had to be given on that day. However, from this date onwards until January 3 improvement was steady. Vomiting ceased entirely on the 31st, and constipation was yielding to purgatives. The necessary daily morphia diminished in quantity until it reached $\frac{1}{4}$ grain, on January 2 chloroform being entirely discarded. Spasms ceased on January 2, but the limb remained in a condition of semi-rigid hyper-extension at both the hip and the knee. The temperature was constant between 97° F. and 98° F. since the 25th.

On the evening of the 3rd, a smart hæmorrhage occurred from the wound; chloroform was given and the wound packed tightly with gauze, and pressure applied with firm pad and bandage. On the morning of the 4th, however, the hæmorrhage having recurred, the wound was once more opened up freely; bleeding vessels in the muscles were secured, and the sciatic artery ligated. The intrapelvic well of the wound was washed out thoroughly with eusol, and some particularly foul-smelling pieces of bone were removed from the ischium in the region of the spine. The sciatic nerve, on exposure, was found to be much less inflamed than during the previous operation, and though slightly discoloured, the former deep purple colour had now gone. The wound was packed with gauze around the catheter as before.

There were no evil effects from the hæmorrhage and no recrudescence of spasms arising from the manipulation; and the patient's progress was uninterrupted from that time forward. The pain rapidly disappeared, appetite returned, and the general condition became quite satisfactory.

The state of hypertonus in the limb gradually diminished, and on discharge from hospital the right lower limb was held stiff at the knee, but slight degrees of flexion at the hip were readily obtained. The ankle and the joints of the foot were never affected throughout and remained quite mobile. Babinski's sign was present on the affected side, but no ankle-clonus; the knee was held stiff, and so no jerk could be obtained. The hamstrings and quadriceps, though less tense than formerly, were still rigid; there was still slight hyper-extension at the hip and knee when lying at rest, but a gradual relaxation of the muscles of the thigh was becoming manifest.

Patient left for England on January 12, 1916.

Remarks.

Here, then, was a case in which, upon the thirteenth day after an injury, there commenced a series of twitches and painful spasms such as not infrequently herald the onset of tetanus. Stiffness of the muscles in the neighbourhood of the wound soon followed, accompanied by spasmodic contractions of certain groups in excess of the others, notably in the flexors of the hip-joint and, at first, in the extensors of the knee, though the latter soon assumed a condition of permanent rigidity. The most marked feature was an appearance of complete and continuous stiffness of the limb as a whole, a condition which, actually, was limited to the muscles of the thigh and spread neither below the knee nor to the abdominal wall, whilst the remainder of the body was entirely unaffected. A definite posture was gradually assumed in which the affected limb showed hyper-extension at both hip and knee, lying stiff as a poker, only moving as the spasms occurred, and then to but a slight extent, since the constant extensor influence was sufficient to overcome to a great extent the spasmodic efforts of the flexors. The disease ran an acute course over a period of twelve days, after which a gradual improvement set in; the last spasms occurred on the eighteenth day, leaving a residual rigidity, which was slowly relaxing when the patient left for England a fortnight later.

Diagnosis.

The main question in the diagnosis rests as to whether or no the condition is one of true tetanus localized to one limb. The outstanding features of the case are, firstly, the complete localization of the trouble to the muscles in the immediate neighbourhood of the wound; and, secondly, the extreme severity of the condition.

A number of cases of tetanus have occurred during this War in which the condition has started in an injured limb, has remained localized in that limb for a varying period of time, and has later involved other parts of the body, usually going on to produce trismus, as in a case reported by Captain T. R. Mouat [1]. In that instance the onset of the disease was manifested by twitchings in the region of the wound for some twenty-five days, followed by involvement of the muscles of the shoulder girdle on the same side. Four days later the muscles of the opposite shoulder were affected, the head became retracted, and trismus appeared. An amelioration, and later a complete cessation, of the symptoms followed administration of antitetanic serum. Such may be truly described as a case of delayed tetanus, localized, for a time, in one limb.

A second and very similar case occurred in No. 11 General Hospital, under the care of Captain J. Campbell, by whose courtesy I am allowed to publish the following details: The patient was wounded on November 15, 1915, and was admitted to No. 11 General Hospital on November 16, 1915, with multiple wounds of the right thigh and leg, and of the left ankle. On November 25, 1915, he complained of marked pains over the sole of the left foot, and a few twitches were noticed in the muscles of the calf. On the 27th definite spasms ensued, very painful, tonic in character, with almost complete interspasmal relaxation, and involving the muscles of the left leg and also, to a lesser degree, of the left thigh, but accompanied by neither trismus nor dysphagia. Ten thousand units of antitoxin were given intravenously, which afforded slight relief for twenty-four hours. On the 29th, 5,000 units were given subcutaneously, whilst the wound was explored. On the 30th spasms were as bad as ever, and the condition of the ankle necessitated amputation below the knee, 10,000 units again being administered intravenously. On December 1, the spasms were definitely less frequent and had not spread to other parts; but on December 2 the abdominal muscles of the left side had become involved and 3,000 units were given intrathecally. No spasms then occurred for three days, but on December 5 there was a recurrence of severe twitching in the stump, and the patient complained of some discomfort about the jaw, though its movements were quite free. Three thousand units were given once more intrathecally; slight twitches of the stump were noticed on the 6th, but after that day there was no recurrence of the spasms at all.

In both these cases there occurred a condition of spasmodic contractions, starting in one limb, at the site of a wound, and slowly

travelling in a central direction. In the first instance, after three or four weeks of local twitching, the condition slowly spread to the shoulder girdles and thence to the neck and to the jaw, thus disclosing a condition of true tetanus. In the second instance a very similar state of affairs was present—twitching and pain in the foot and calf, spreading to the thigh and finally to the abdomen; administration of antitoxin followed by alleviation, then a few days later a recurrence, a further course of antitoxin, and finally a cessation of the spasms. Here apparently the condition was cut short before it had been able to reach the masseters by repeated intrathecal injections of antitoxin.

Both these cases, however, differ in a marked degree from the case under the writer's care. There the spasms and rigidity remained entirely localized in the muscles first involved, and were in no way alleviated by intrathecal administration of antitoxin; nor, when the latter was discontinued, did the spasms spread, either upwards to the abdominal walls or downwards to the muscles of the calf or foot. The severity of the condition was unmistakable: very frequent spasms on top of the continuous state of rigidity in the opposing muscles was such as is only seen in the most acute cases of generalized tetanus. There was none of the delay between the onset of twitching and the development of acute spasms, such as was noted in the other two cases.

On the other hand, there have been three cases recorded by Lieut.-Col. Rudolf [2] in which the course of the disease and the definite limitations of the parts affected are almost identical with those of the case here recorded. In each case a wound of the thigh or buttock was followed by a condition of constant rigidity, localized in the muscles of the limb affected, during which violent contractions would occur. In two of the three cases the spasms commenced on the eleventh day after the infliction of the wound, whilst in the third they actually started as soon as the man received his injury. In all three of these cases there occurred the same rapid onset of acute symptoms, the same absolute localization of the spasms, even in the most acute stages, and the same persistent rigidity of the limb over a long period, gradually passing off during convalescence—just as occurred in the case under the writer's care—and together presenting a clinical picture quite different to that which was seen in the two cases of delayed tetanus in which the symptoms were, for a time, localized in the wounded limb.

On comparing these two groups of cases one is driven to the conclusion that they must represent two quite separate clinical and

pathological conditions. The one group would appear to illustrate a condition of true tetanus, probably modified by a previous prophylactic injection of antitoxin, of gradual onset and slowly advancing, but none the less quite capable of extension as far as the masseters, and culminating, unless freely treated with antitetanic serum, in a typical condition of lockjaw. In the second group, however, the condition never advances beyond the immediate neighbourhood of the wound, and, in its own closely confined area, runs an exceedingly acute course quite unaffected by antitetanic serum; it would be comparable rather to a most violent attack of tetanus absolutely cut off from the rest of the body, unlimited in severity but limited most markedly in distribution. Can this condition be considered as due to tetanus at all when compared with the first group of cases, which do undoubtedly belong to that category? Or might the cause not be found in some other organism, associated probably with anaerobic wound infection and capable of producing a toxin similar to that of true tetanus, but differing in its distribution and methods of spread in the body? It would be of great interest to try and produce such toxin by growing *in vitro* the various anaerobes found in sloughing wounds, and then, by animal inoculation, to attempt to reproduce the clinical conditions described above.

The question of the spread of the toxin requires elucidation; the possibility of the lymphatic distribution to the muscles affected, and a course then along the specific nerve trunks to definite cornual cells, without power of further intracornual migration, might be considered, in view of the entire freedom of the muscles of the foot and leg in the case where the whole thigh was involved in agonizing spasms.

In three out of the four cases of this type there was apparently a definite incubation period of from ten to twelve days, which closely resembles that most commonly occurring in cases of true tetanus. In the fourth case, however—the first in Colonel Rudolf's series—the spasms started immediately the wound was inflicted, a condition which would coincide neither with tetanus nor with any other wound infection, but which would suggest a direct introduction of the toxin into the wound, with a purely local action, rather than any poisoning of the cornual cells.

As far as treatment goes, in view of the failure of antitetanic serum, one was forced to fall back upon purely symptomatic remedies. Morphia was given in great quantities—twenty-five grains in ten days, and as much as four grains in twenty-five

hours; a toleration for the drug was apparently developed, as no sign of pin-point pupil was ever seen, and no depression of the respiratory centres. Chloroform, as in generalized tetanus, was invaluable, and was administered just as in labour, very little at a time being sufficient to allow of a brief rest, and to give the morphia a chance to produce its effects.

The exhaustion produced by the spasms was so great that the question of myosection of the affected muscles became worthy of serious consideration. Possibly in the future a new antitoxin will be available which will affect this condition of localized spasm, just as the antitetanic serum is able to attack the poison of true tetanus, whether localized in its action to one extremity or generalized over the muscles of the whole body.

Such, then, is a brief account of a condition which might almost be termed "para-tetanus." Rare in the extreme, even by contrast with true tetanus, it presents certain features worthy of description, and appears to merit classification as a definite clinical entity for which, up to the present, no adequate pathological explanation has been forthcoming.

REFERENCES.

[1] *Lancet*, January 22, 1916.
[2] *Ibid.*, November 13, 1915.

BACTERIOLOGICAL INVESTIGATIONS UPON SUSPECTED CASES OF TYPHOID FEVER.

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I.—Introduction.

From July 10 till September 29, 1915, I carried out the bacteriological examinations on materials derived from the patients at hospital. Out of the 1,001 specimens examined during a period of eleven and a half weeks 842 referred to "typhoid suspects" and included 134 examinations of blood, 362 examinations of urine and 346 of fæces. No more than one sample of blood was taken from a patient, but samples of urine and fæces were examined repeatedly in some cases. In all 200 typhoid suspects were examined, whence it appears that blood examinations were wanting in one-third of the cases.

II.—Methods.

The same methods were employed throughout the period.

Blood.—About two cubic centimetres were removed from a vein with aseptic precautions, introduced into a tube containing ten cubic centimetres of sterile ox-bile, and incubated twenty-four hours at 37° C. From this material a MacConkey plate was inoculated by the brush method described below. In the event of no growth appearing on the plate after twenty-four hours' incubation it was re-inoculated with the original material, which by now had been incubated for forty-eight hours.

Urine.—A sterile test-tube was supplied and the patient was instructed to half fill the tube after having passed a portion of the stream in order to cleanse the urethra. On receipt of this tube, which contained about ten cubic centimetres, sodium taurocholate was added to produce (approximately) a one per cent solution, the mixture was incubated twenty-four hours, and MacConkey plates were inoculated and incubated. It was found more convenient to make as concentrated a solution of sodium taurocholate as possible, and add 0·1 c.c. to each tube of urine. Very great exactness does not appear to be necessary.

Fæces.—An emulsion was made and six loopfuls were inoculated into ten cubic centimetres of Browning's brilliant green and telluric acid medium. Owing to pressure of work a single tube of culture

was used instead of the series recommended by Browning,[1] and it was found that 0·04 c.c. of a one per cent solution of telluric acid and 0·5 c.c. of a 1 in 10,000 solution of brilliant green added to ten cubic centimetres of peptone water immediately before use was satisfactory. The one per cent telluric acid was kept in bulk; the brilliant green was prepared from a stock solution of 1 in 100 immediately before use. After inoculation with the emulsion the tube was incubated twenty-four hours and then a MacConkey plate was inoculated and incubated.

Brush Method.—The method of inoculating plates I have adopted for many years is as follows: Very fine camel's hair pencils without holders are sterilized in 1 to 20 carbolic for some hours, well washed in sterile distilled water, and stored singly in small sterilized test-tubes plugged with cotton-wool and containing about two cubic centimetres of sterilized water. When a plate is to be inoculated, the brush is removed from its test-tube by thrusting a flamed glass rod down the quill, the point dipped into the material to be plated, drained as far as possible by rotatory pressure against the side of the tube, re-introduced, and vigorously shaken in the water of the tube from which it was taken originally, and drained again as far as possible by rotatory pressure.

This charged brush is now lightly drawn in parallel streaks over the face of the medium in the plate to be inoculated without altering the position in which it is held. As a result the medium becomes inoculated more and more sparsely, and in the large majority of cases some portion of the plate shows single colonies that are well separated. The plates themselves should be poured the day before use to ensure that the surface of the medium is devoid of droplets of moisture.

III.—Results.

(1) *General.*—Among the 200 cases one or other member of the typhoid group of organisms was found in 49 (24·5 per cent) viz.: *Bacillus typhosus*, 6; *B. paratyphosus* A, 17; *B. paratyphosus* B, 26. Among the remaining 151 cases, 6 afforded growths of members of the *B. coli* group in the blood, urine and fæces, and 11 similar growths in the blood and fæces, the urine being sterile or showing other micro-organisms or not having been examined; while in 3 cases they were found in the urine alone and

[1] Browning, Mackie and Smith, *Journ. Path. and Bact.*, 1914, vol. xix p. 127.

in 29 in the fæces alone. Thus 71 cases in all (35·5 per cent) yielded greater or less evidence of coli infection.

Further, among the 151 cases in which a member of the typhoid group was not found, 15 cases afforded growths of micrococci in the blood, urine and fæces, and 25 showed micrococci in the blood alone, 8 showed them in the blood and urine, 9 in the blood and fæces, 4 in the urine and fæces, 3 in the urine alone, and 1 in the fæces alone. Thus 65 cases (32·5 per cent) showed greater or less evidence of micrococcal infection.

Fifteen cases were not classified owing to the variability of the results obtained.

These figures are tabulated below.

	Blood, urine, fæces	Blood, urine	Blood, fæces	Urine, fæces	Blood	Urine	Fæces	Total	Percentage
B. typhosus	..	..	..	..	..	1	5	6	3·0
B. paratyphosus A ..	..	..	..	..	3	4	10	17	8·5
B. paratyphosus B ..	..	..	..	1	1	16	8	26	13·0
B. coli group ..	6	..	11	31	..	3	20	71	35·5
Micrococcus group ..	15	8	9	4	25	3	1	65	32·5
Unclassified	—	—	—	—	—	—	—	15	7·5

Although the results have been summarized as above, it must not be supposed that the cultures obtained were necessarily pure, though this is generally true in the case of blood cultures. Not infrequently micrococci or colon bacilli or both were found along with the particular micro-organism or group under which a given case is classified. Thus, a plate in which *B. paratyphosus* B was isolated from the urine showed the presence of other micro-organisms, while the blood contained *B. coli* in pure culture and the fæces showed the presence of *B. coli* and streptococci. Such a case is returned in the table under the heading "*B. paratyphosus* B" and the other micro-organisms found are neglected. Similarly, some of the cases classified under *B. coli* group also showed the presence of micrococci, and vice versa. But no case appears in two groups.

Scattered throughout the series were instances in which *B. fluorescens* occurred. It was present in fifty-four out of 362 plates made from the urine, and in twelve out of 346 plates made from fæces. In no instance was it found in plates made from the blood, and in only one case did it occur both in urine

and fæces. The chief interest accruing to its presence is that some varieties appear to be feebly agglutinated by anti-sera of the typhoid group, and since the organism is Gram-negative, motile, and a non-lactose fermenter, it is liable to be confused with members of the typhoid group, unless it be present in sufficient quantity to produce its characteristic colour and offensive odour. It is impossible to say whether it is of pathogenic significance.

(2) *Cases in which a Member of the Typhoid Group of Bacilli was isolated.*—In arriving at a diagnosis for clinical purposes sole reliance was placed upon the agglutination of the bacillus under examination with one or other of the antisera of the typhoid group in a dilution of 1 in 300 within half an hour. Later, a dilution of 1 in 100 was used in addition, but it was not found that material advantage accrued, since a true member of the group has always been found to agglutinate at 1 in 300. Moreover, use of a higher concentration was liable to complicate diagnosis, because at 1 in 100 there is apt to occur a certain amount of agglutination with one or other member of the group antisera than that to which the organism in question is ultimately referred, on the basis of its continued agglutination with degrees of antiserum dilution in which its congeners fail.

The number of cases included in this group is of the nature of a maximum, since a diagnosis was always returned forty-eight hours after receipt of the material, and as a precautionary measure a few doubtful cases were diagnosed as positive. Subsequent re-investigation of the bacilli isolated substantiated the original diagnosis in all but a small minority of cases, even to the question of the particular member of the typhoid group concerned. During the latter half of the period, acting on the instructions of Colonel Sir William Leishman, I carried out a series of investigations on sugar and other reactions with each organism diagnosed as belonging to the typhoid group. The results of these will be dealt with briefly at the end of each section.

It is unnecessary to refer at length to the characters of the colonies formed by the micro-organism on the MacConkey plate. They are practically always round, white, semi-opaque, but with translucent edges, and of medium to large size in the case of *B. paratyphosus* B. In the cases of *B. typhosus* and *B. paratyphosus* A, a similar description of the colony generally holds good, but there appears to be greater variation, sometimes the colonies being minute and sometimes being of a pale pink or ochrey tinge instead of white.

(*a*) *Bacillus typhosus.*—Six cases (three per cent.) were diagnosed as typhoid fever by isolation of an organism deemed to be *B. typhosus* from the fæces (five cases) or urine (one case), owing to its agglutinability by antityphoid serum 1 in 300 dilution in half an hour. Possibly because all the diagnosed cases occurred in patients who had received antityphoid inoculation, the diagnoses have only been relatively free from doubt. Thus in only one case was the agglutination at 1 in 300 dilution noted as "very marked," and here the maximum dilution for clumping was only 1 in 900. In the remainder it was noted as "fair," and the maximum dilution was 1 in 600 to 1 in 400. Moreover, in four out of the six cases "slight agglutination" or "a trace" occurred with antiserum of *B. paratyphosus* A (1 in 300 dilution). In no instance was agglutination observed with antiserum of *B. paratyphosus* B in 1 in 300 dilution for half an hour.

From a morphological point of view the organisms conformed fairly well to type, though in two instances they were noted as being "longer and thinner" than is usually the case with *B. typhosus*, and in yet another as "very variable in length"; they were all Gram-negative and motile, though the latter in variable degree. On replating from the original cultures, variations were found, and in particular agglutination was less marked, and one case showed general group agglutination. In five instances the organisms were cultivated in broths containing lactose, glucose, dulcite, mannite, in neutral red glucose agar and in litmus milk. The results were very variable. Thus two cases showed neither acid nor gas in lactose broth; a third showed late formation of acid and gas; the fourth showed late formation of acid, but no gas; while the fifth showed late formation of gas, but no acid. Similar differences showed themselves with the other media, the only consistent result being obtained with dulcite broth, in which neither acid nor gas was ever observed. In litmus milk the reaction remained alkaline throughout in one case, but in all the others became acid after a few days: observed for three weeks, the reaction never was seen to return to alkaline; late clotting occurred in two cases.

(*b*) *Bacillus paratyphosus* A.—Seventeen cases were diagnosed as belonging to this group by their agglutination reactions—three being isolated from the blood, four from urine, and ten from fæces. In ten instances the clumping in 1 in 300 dilution in half an hour was "very marked," but in three of these there was some agglutination; also with the antisera of *B. typhosus* and *B. paratyphosus* B.

In six instances the clumping was "fair," and in three of these some agglutination was observed with the other two antisera. The last case showed "a trace" of agglutination with anti-paratyphoid A serum 1 in 300 dilution in half an hour, and no clumping whatever with either of the two other antisera under the same conditions. Culturally the organisms conformed to type, but in four instances they were noted as being "longer and thinner" than typical *B. typhosus*. In nine cases cultivations in sugars and in litmus milk were made: three showed acid formation (usually late) in lactose broth, and one of these formed gas as well. The remainder formed neither acid nor gas. Eight of the nine formed neither acid nor gas in dulcite broth or in mannite broth, the ninth forming both. This same organism was the one already noted as forming acid or gas in lactose broth. It is noteworthy that it agglutinated in a dilution of 1 in 2,000. Seven of the nine cases clotted milk.

(*c*) *Bacillus paratyphosus* B.—This series comprises the largest number of cases, and is the most satisfactory both from the point of view of agglutination and from that of general uniformity in respect of fermenting properties on the various sugars. Twenty-six cases were diagnosed as belonging to this group, the organism being isolated in one instance from the blood, sixteen from the urine, eight from the fæces, and once from both urine and fæces. In twenty-three cases agglutination by the specific antiserum in 1 in 300 dilution in half an hour is noted as "very marked," and in the remaining three as "fair." Slight agglutination with one or both of the other antisera of the typhoid group occurred in six cases, but in comparison with that occurring with the *para-typhosus* B antiserum was negligible. In two instances the maximum dilutions of the antiserum in which agglutination was observable were 1 in 350 and 1 in 400, the majority agglutinated at 1 in 2,000 or upwards.

The sugar and litmus milk reactions were very consistent, though variations were found. Thus one case showed acid and gas in lactose broth, and one formed acid but no gas; the remainder formed neither acid nor gas. All formed acid in glucose broth, and all but one formed gas as well. Eleven formed acid and gas in dulcite broth, though in some cases the gas formation was late in onset, and in others the reaction from becoming acid reverted to alkaline after a few days. One case formed no acid at all, and yet another neither acid nor gas. In all instances mannite broth was acidified, and in all but one gas was formed in addition, Litmus

milk in all but one case became acid, and in about half the cases clotting occurred in addition. In the accompanying table an impressionist view is given of the results obtained with the three types of bacilli on cultivation in various sugar broths and in litmus milk.

		Lactose	Glucose	Dulcite	Mannite	Litmus milk	
B. typhosus (5 cases)	Acid	Variable	Variable	..	Variable	Acid	+
	Gas			..		Clotting	Variable.
B. paratyphosus "A"	Acid	..	..	..	..	Acid	+
(9 cases)	Gas	..	..	..	..	Clotting	+
B. paratyphosus "B"	Acid	..	+	+	+	Acid	+
(13 cases)	Gas	..	+	+	+	Clotting	Variable.

(3) *Cases in which Members of the* Bacillus coli *Group were isolated.*—Under this heading are included cases in which the MacConkey plate developed medium size to large colonies, having a red colour due to acid formation. It is clear that the mere formation of acid cannot be taken as a proof that the organism in question is one or other variety of *B. coli*, though *B. coli* normally forms a medium size to large pink colony with a deep red centre on a MacConkey plate. An exception exists when it occurs along with *B. fluorescens*, the alkali formation of which is so great that the acid produced by *B. coli* is neutralized, and colonies of the latter remain white. Used in this loose sense, it may be said that amongst the 200 typhoid suspects examined 71 showed the presence of members of the coli group. Of these 20 may be dismissed summarily from consideration, inasmuch as the organisms in question were obtained from the fæces alone. Other 31 cases in which they were found in urine and fæces may be put on one side, though the fact that *B. coli* group organisms were found in the urine also may not be without significance. But in 6 cases members of the *B. coli* group were found in cultures from blood, urine, and fæces, and in 11 cases in addition they were cultivated from blood and fæces. Further investigation alone could decide whether there exists a variety of intestinal disorder, simulating enteric fever in some degree, but in which a member of the *B. coli* group is the exciting agent.

(4) *Cases in which Micrococci were isolated.*—Under the heading are included 65 cases in which micrococci were cultivated. Of these, 25 cases produced a growth of micrococci from the blood alone, 3 from urine alone, 1 from fæces alone, 8 from blood and

urine, 9 from blood and fæces, 4 from urine and fæces, while 15 cases afforded micrococcal growths from blood, urine, and fæces.

As a rule, other micro-organisms besides micrococci were present in cultures from urine or fæces, but cultures from blood were generally pure and numerous colonies developed.

The organisms were met with as minute colonies on the MacConkey plates, and sometimes were definitely red in colour, sometimes white or pale pink. In both of the two latter cases the medium beneath the organisms was pink, owing to acid production and diffusion into the medium. Rarely the colonies were definitely white. In a large number of cases examination in a drop of water showed that the organisms were streptococci, chains of four or more individuals being seen; in others, though separate pairs or short chains of three occurred, it was impossible to decide whether the growth was streptococcal or staphylococcal. Minuteness of the colonies was quite characteristic after three to four days' growth.

Out of 134 plates examined for the purpose the organisms were Gram-positive in 84 and Gram-negative in 50. In 7 cases it is noted that some of the cocci of a film were Gram-positive and others Gram-negative.

As in the cases included in Group (3) (*B. coli* group) it is impossible here to assert in a given case in which micrococci developed from blood, urine, and fæces, that the strain of micro-organism was identical in all three materials. This is a subject for further investigation, but it is not impossible that certain characters of of the micro-organism should vary according to the material from which it was isolated.

In none of the cases included under (3) and (4) was a member of typhoid group found, but with this exception there was considerable interchange. Colonies of micrococci or members of the coli group might be found in large numbers on a plate in which a few colonies of one of the typhoid group determined the class into which the case should be placed. The same is true for members of *B. coli* group. Thus one case showed a pure culture of white colonies of Gram-positive cocci in the culture from the blood; *B. paratyphosus* B with no micrococci but a few *B. coli* colonies in the culture from the urine, and a single colony of *B. paratyphosus* B with no micrococci and numerous *B. coli* colonies in the culture from the fæces. This case was returned, of course, as *B. paratyphosus* B, but the possible occurrence of mixed infections cannot be denied.

In conclusion, two points suggests themselves for consideration:—

(1) If it be true, as the observations noted under (3) and (4) seem to suggest, that morbid conditions involving the intestinal tract in a somewhat similar way to "enteric fever" can exist, which are closely associated not with one or another of the typhoid group bacilli but with members of the *B. coli* group or with micrococci, a satisfactory classification of many "typhoid suspects" would become possible. At present those cases in which no member of the typhoid group is found bacteriologically cannot be classified in a satisfactory way.

(2) The fact that streptococci in particular have been found in the blood with considerable frequency raises the question whether some of the streptococcal infections of wounds met with so commonly in the present campaign may not be autogenous. If this be so, the method of wound treatment would call for some reconsideration.

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TREATMENT OF WOUNDS FROM FIRE TRENCH TO FIELD AMBULANCE.

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This paper has been written, not with the idea of laying down any dogmatic rules for the treatment of wounded, but rather to focus attention on the various methods employed, and, by a statement of what our experience has been, to stimulate a discussion from which it is hoped we may all gain valuable information.

Let us commence with the treatment in the fire trench or aid post. I think it is advisable to consider it under two headings:—

(*a*) In ordinary times.

(*b*) During a battle.

In the first case, the wounded are few in number, and plenty of time is at the disposal of the medical officers for their treatment. In the second, the medical officers are working under pressure, probably not under the most ideal conditions for surgery, and therefore can neither give time nor individual attention to each case.

At Ordinary Times in the Trenches.

In the large majority of cases the wounded will have received first-aid treatment from the regimental stretcher-bearers before being seen by the medical officer. Consequently, it devolves on the medical officer to train them so as to make their treatment as efficient as possible. The stretcher-bearers should be men of intelligence who are actually interested in their work, and on no account should they be men who have been selected because they are useless or physically incapable of regimental work. The work of the stretcher-bearer is very strenuous, and requires a man of strong physique.

There are three things in which the stretcher-bearer should be proficient: (*a*) The first-aid treatment of wounds; (*b*) the control of hæmorrhage and the treatment of fractures; (*c*) the various methods for the removal of wounded from the trench to the aid post.

First-aid Treatment of Wounds.

The stretcher-bearer is bound from his surroundings to be a most septic individual, and even with the best intentions in the world cannot render himself aseptic. Consequently, it should be impressed upon him

that on no account is the wound to be touched. This fact must be well driven home; perhaps it might help if it was explained to him that his hands are covered with germs, and that if, by touching the wound, he should introduce only a single germ, that microbe will have the power of reproducing itself to the extent of five or six millions in twenty-four hours. This wonderful reproductive fact is sure to strike the average "Tommy." Having got this fact impressed, the next thing is to instruct him how to approach the wound. This is a difficult problem, as with many wounds it is necessary to remove the clothing, which will expose the patient to the danger of "cold," and in the case of a large wound may add considerably to the shock. Personally, we feel that, under present conditions, where, with good communication trenches, it is possible at all hours of the day to remove the patient to the aid post, as little exposure as possible in the trench should take place.

Even with a well-fitted-out medical dug-out in the trenches we do not think any exposure is justified unless the medical officer is there and can personally carry out a proper dressing. We see no reason why a small portion of the clothing cannot be cut away when it immediately surrounds the wound, rather than undressing the patient, and a field or shell dressing applied; this would entail very little exposure and be far better than the indiscriminate cutting-up of the clothing which often happens now. A criss-cross cut made opposite the wound, and the flaps turned back, answers very well. Even in cases of severe bleeding, where a tourniquet has to be applied, complete exposure is not necessary, as the site of the wound is shown by the hole in the clothing, and further, the presence of the clothing will prevent the tourniquet bruising the skin. We also feel that full exposure of a wound means an added danger from further infection.

Control of Hæmorrhage.

We are inclined to think that tourniquets are an invention of the Evil One, and that it is no exaggeration to say that many limbs have been lost during this campaign by the indiscriminate use of them. We do not mean to say that, if a man is shot in the femoral or other large vessel, a tourniquet is not required, though here the majority of cases would be dead before a tourniquet could be found and applied. Our contention is that practically all external hæmorrhage can be controlled by firm pressure with a pad over the bleeding point, at least until the field ambulance is reached, where it can be thoroughly dealt with. Such a pad can be made from a first field dressing or, if necessary, two field dressings, one on the top of the other. We know that there is the possibility of bleeding into the tissues, but this risk is small compared with the damage done by an unnecessary tourniquet. It should be remembered that, on the average, at least three or four hours must elapse before a case can be got from the fire trench to the field ambulance; and in that time a tourniquet may do

irreparable damage. The Japanese method of attaching a strip of red flannel to cases wearing a tourniquet is worthy of notice. If, after applying these pads, the stretcher-bearer finds that considerable bleeding is still taking place, then he should use a tourniquet. We strongly advocate the issue of the round rubber tourniquet in place of the web tape with buckle, as it is more easily applied and more effective. A very simple and, at the same time, effective tourniquet can be improvised with a puttee and a piece of stick, the width of the puttee preventing any undue constriction. Where a limb is badly lacerated, the hæmorrhage is seldom very considerable owing to twisting of the vessels, but the possibility of its occurrence should be watched for. The stretcher-bearer should also be instructed where to apply immediate digital pressure in case of injury to one of the large vessels.

Fractures.

We think it advisable that the stretcher-bearer should not apply splints to a fracture, especially of the lower limb, as it is very doubtful, when in the trenches, if he could apply them satisfactorily, and it would, besides, take a considerable time. We recommend that a fractured arm be bandaged against the trunk; and that, with fractures of the lower limb, the two feet be brought together and tied firmly, and again tied at the knees. In this way sufficient immobilizing of the limb will be obtained to move the wounded man to the aid post.

Methods of Removal.

This now, with the present trenches, tramroads and communication trenches, is not difficult, as in practically all cases the wounded man can be carried on the ordinary stretcher. Cases may arise, however, where an ordinary stretcher cannot be used, where it may be necessary to use a Rogers's trench stretcher. This stretcher has not always found favour with the medical officers, but we think, with a little practice, the stretcher-bearers will find the advantage of it in certain circumstances. The wounded should be removed to the aid post as soon as practicable after having been wrapped in blankets, it being remembered that any shock causes a rapid fall of temperature. Patients should be allowed to lie on the stretcher in the position they find most comfortable for breathing and ease, and not according to any hard and fast rules. Some sandbags might be kept filled with straw for use as pillows, which will add much to the comfort of the wounded man.

At the Aid Post.

The medical officer should see all cases, and redress them except in the most trivial cases. It should be remembered that the first field dressing is an emergency dressing for application by the man himself or his companions, and was never intended to be looked upon as a

permanent dressing. In wounds of the limbs, if tied tightly, it frequently becomes so tight from the swelling of the limb that it becomes a serious menace to the circulation. The stretcher-bearers should be specially warned of this, so that, in applying, he can make some allowance for this swelling.

Head cases should have the hair shaved off for at least two inches round the wound. It is not sufficient to clip it with scissors.

Chest and abdominal wounds should have a good pad of dressing applied over the wound, and retained in position by strapping; a bandage should never be passed round and round the body, as that entails additional movement for the patient. Protrusions of gut should be surrounded by lint wrung out in warm saline and covered with protective.

Fractures will require to be splinted. The question of extension does not arise at this stage—a good position is all that can be aimed at. A roll of Gooch's splinting will be found useful to cut splints from. A hypodermic injection of ½ grain morphia will ease the pain during manipulation.

When a wound appears dirty and encrusted with mud, it should certainly be washed with 1 in 60 carbolic or 1 in 1,000 mercury lotion. The dressings should be kept in biscuit tins and handled only by the medical officer, who should try and carry out the ordinary rules of antiseptic surgery in respect of these dressings. The dressings should not be handled by the stretcher-bearer unless he has been trained to carry out these rules. The dressings for wounds should be kept distinct from those used at the morning sick parade, where they are liable to be frequently handled by hands none too clean. The dressings most suitable are cyanide gauze with a plentiful supply of cotton-wool to prevent constriction by the bandage when swelling takes place. The surrounding skin should be well painted with four per cent iodine, which will destroy most skin organisms. If hairs are present on the surface they should be shaved off.

Treatment of shock is a point sometimes overlooked. It must be remembered that, after any wound, the temperature falls rapidly. Therefore the patient should be wrapped up in blankets. The boots should be removed from all stretcher cases, and loosened in that of walking patients, as this adds greatly to their comfort. Warm drinks or water should be given liberally, it being remembered that in all cases where hæmorrhage has occurred the system calls out for water. This is only contra-indicated in abdominal wounds, where it should only be given in sips, and under the orders of the medical officer. Chest and abdomen cases should be warned against any sudden movements, either by the patients or attendants.

Morphia may be given freely in all cases, and in order to get the maximum result, it is advisable to give it hypodermically. We have seen many cases where it has been given by the mouth without any

appreciable result. It is especially indicated in wounds of the abdomen and thorax, as it tends to keep the patient quiet, and so prevents movement. We also think the use of morphia helps to tide over the period of shock. It can be given in much larger doses than is generally taught without any ill effect. All cases that have had much hæmorrhage should be made to lie down with the head low, and on no account to sit up. Brandy may be given in cases with much collapse, both for its mental and physical effects.

In Battle Times.

Here the conditions are entirely altered, as the numbers of wounded have made it practically impossible for the medical officer to give individual attention to all the cases, his attention necessarily being called to the most serious. The exactness of surgical technique has more or less to give way to speed, in order that the cases may be got away to the field ambulance as speedily as possible, both for the benefit of the wounded and to prevent chokage in the front line. The suggestions already given for treatment should be carried out as closely as possible. It will be found that probably first field and shell dressings will have to be used more frequently than in the "quiet time," and therefore it is again necessary to draw attention to the danger of tieing the tapes on these dressings too tightly, as it is quite probable that delays may occur, preventing the case getting to the field ambulance for some considerable time. The same warning will equally apply to tourniquets. Fractures should be immediately immobilized in splints before removal. Rolls of Gooch's splinting will be found most useful, as splints of varying size can be cut as required from the roll, which, besides, is compact and easily carried. A bottle of liquid morphia hypodermica should be carried by the medical officer, as being more handy for use than the tablet, and far more effective than oral adminstration. Water should be given freely to the wounded, and clothing cut up as little as possible. The wounded should be encouraged to walk whenever possible, in order that the ambulance and regimental stretcher-bearers may be used for the carriage of serious cases.

The Field Ambulance.—The rôle played by the field ambulance in modern warfare is that of a "drainage company," which aims at counteracting, as far as possible, the inevitable sepsis of all wounds. It was this "inevitable sepsis" which took us some time to realize, in the early part of the War, trained as we all were in the aseptic school. Soon it was found that all sutures closing wounds simply prevented the escape of pus, and experience showed that the more open all wounds were left the better were the results obtained. Hence the duty of the ambulance is to open rather than close the wound, and so provide for the free escape of all discharges. This drainage of wounds should be carried out in a thorough manner, otherwise it is useless, and we may be excused, therefore, if we

go into it a little fully, as we feel it is of the greatest importance for the future recovery of our wounded and the shortening of convalescence—both points of primary importance to an army in the field. In January of last year we started using drainage tube of the diameter of ½ inch to one inch, and have continued doing so ever since, the drainage tube as found in the surgical panniers being too small to be of much use. Small and superficial wounds and wounds of muscle with small points of entry and exit with no injury to bone do not require drainage, or at least should be given the benefit of the doubt, as they frequently arrive at the base quite clean when dressed with a four per cent iodine solution and dry sterilized gauze. In wounds, however, of any size, and where a bone is involved, drainage must be free. Frequently we have found, with only a small wound of entry and exit, but where the bone has been injured, that on opening up there is a large cavity inside. Drainage, to be of any use, must be free, so in the majority of cases requiring drainage it is necessary to give an anæsthetic. Counter-opening may be required, in the making of which the future position of the limb in subsequent dressings must be considered, and, if possible, they should be made through the most dependent point. The counter-openings should be large enough to admit the drainage tube easily. A tube should never be passed diagonally across a fractured limb, so as to traverse a defect in the bone or to lie in close proximity to any large vessel. The tubing should have numerous lateral openings cut in it, or be slit right up, and if it be slightly pointed at one end and the bullet forceps found in the operation case be passed through the wound tract and used to grasp this pointed end, no difficulty will be found in introducing the largest size tubing. Care should be taken to insert a sterilized safety pin into the end of the tubing to prevent it slipping in, and the tubing should be cut off fairly short to prevent the end being closed by the pressure of the dressings. It is better to err on the side of over-doing rather than underdoing the drainage, free drainage being the one preventive of gas gangrene. In some cases it is better to cut through any small bridges of skin and muscle, so as to allow of subsequent free granulating. Occasionally, wounded come in who have laid out for some time after the receipt of their injury, and who may show symptoms of gas gangrene in varying degrees. This condition is easily recognized by the smell and by a dirty brown fluid which escapes from the wound, and it requires to be very freely opened up, both by incisions into the muscles and by drainage tubes.

Anæsthetics.—They should be given in the majority of wounds of any size or severity, and experience has shown that they are required in about ten per cent of all wounds, otherwise it is quite impossible to carry out a thorough cleansing and drainage of the wound. Open ether is the ideal anæsthetic, both from the point of view of immediate safety and from the subsequently depressing effects of chloroform. No difficulty

will be found in producing complete narcosis with a little practice. One-hundredth of a grain of atropine, with or without morphia, should be given if possible beforehand.

Dressings.—They should be all sterilized. We have been fortunately situated in having a steam sterilizer, but one can be easily improvised from a biscuit tin. We have lately used a method of sterilizing of dressings for minor wounds which we find most excellent, as it avoids soiling a large amount of dressings; while, for the large wounds, we use dressings from the drum of the sterilizer. We also use this sterilizer for towels and operating gowns.

The wound we wash with warm water and ether soap, then bathe in a lotion of either 1 in 1,000 mercury or 1 in 60 carbolic, followed by ether, and finally swab as dry as possible before painting with four per cent iodine. In no case should iodine be applied to large raw surfaces, as it is useless owing to the moisture present in these cases. The iodine should always, however, be painted on to a wide area around the wound. Cyanide gauze is then applied. If a large raw surface has to be dressed, we find that gauze soaked in equal parts of peroxide of hydrogen and glycerine is good, as it will prevent the gauze from sticking when redressed. Plugging of wounds should be avoided, as it interferes with the drainage, and it must be very occasionally that it is necessary for stopping hæmorrhage in that manner. The bleeding points should be cut down on and ligatured, as they are generally easy to find. We use boiled silk for all ligatures. Gloves should be worn, both as a protection to the patient and to the operator's hands from the effects of the antiseptic lotions. Portions of projectile we leave, unless easy of removal or a cause of discomfort to the patient.

In serious head injuries we shave the head, an operation which should never be done unless the patient is under an anæsthetic. The question of the necessity of an immediate trephine to relieve grave pressure symptoms must be left to the experience of the surgeon. We had excellent results last winter from cases treated by us, as at that time we were allowed to retain them for ten or twelve days.

Fractures we treat on the general lines laid down. No fragments of bone should be removed unless absolutely free and of small size.

There are several splints that we find most useful:—

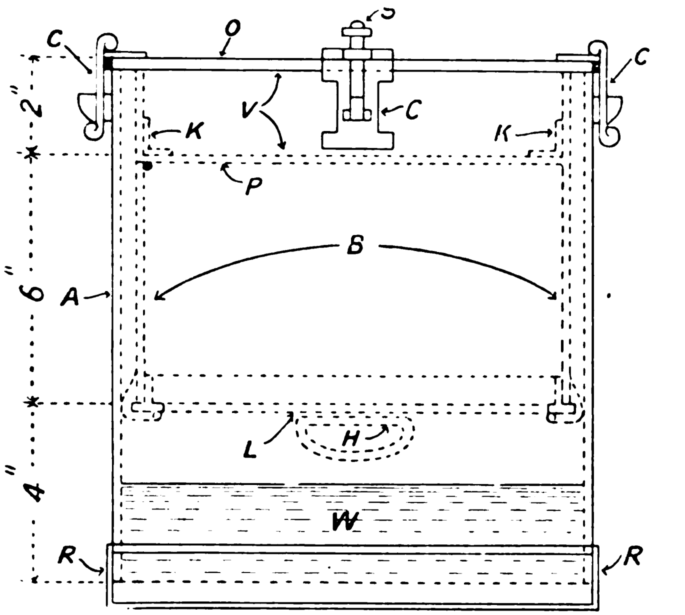
(1) Page's arm and femur splint.

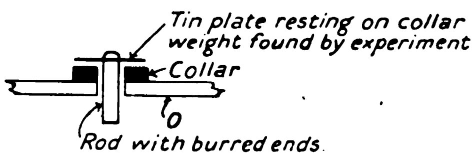
(2) Our leg splint.

(3) Thigh splint with interruption.

Shock and Collapse.—All cases show this in varying degrees, and the treatment runs on more or less general lines. When admitted, the patient should have any wet clothing removed, boots taken off, and dry socks put on. Bed boots made of flannel or other warm material, and reaching to just below the knee, will be found useful. He should be well wrapped up in blankets, and with hot-water bottles if necessary.

Warm drinks should be given—patients prefer cocoa or tea to bovril. Water should not be stinted if asked for. We find morphia an excellent line of treatment, as it composes the patient and he drops off to sleep. Morphia is especially useful in wounds of the chest with pneumothorax, which seem to produce great mental shock. If collapse is severe, especially if due to hæmorrhage, we find elevation of the feet, the use of pituitrin and subcutaneous or intravenous injections of normal saline give excellent results. With a medium-sized needle from the Potair aspirating case and a funnel and tube, a couple of pints can be quickly run into the axilla or thighs. Continuous saline by the rectum is impossible to carry out in the field ambulance.





Section of valve.

Improvised Dressings Sterilizer.

A, water tank or boiler (twelve inches deep by eleven inches diameter), with strengthening rim, R.

B, dressings container (six inches deep by ten inches diameter), with perforated bottom, P, and perforated lid, L. H is a wire handle for lid.

O, the outer lid—to which B is permanently attached—is held tightly down on the top of A by four clips, C, thus compelling the steam to pass through B into the space V, thence into the open air through the safety valve, S, which is in the centre of O.

Construction.—A is an oil drum cut down. B is an inner cylinder (of tin in this case) with a loose bottom, P, resting on brackets, K, in this way (when lid, L, is removed) giving access to the safety valve, S.

Principle.—The water, W, turned into steam is forced to pass through B to reach the outer air, and only then at a greater pressure than one atmosphere. When boiling ceases, a partial vaccuum ensues, thus drying dressings.

Discussion.

Colonel Skinner, A.M.S., asked speakers to divide the discussion into two:—

(1) Treatment from aid post forward.

(2) Treatment at field ambulance.

Captain MacLean, R.A.M.C., agreed with most of Major Blackwood's remarks. He emphasized that blankets should be put under the patient as well as over. He thought that a tourniquet could be put on by the bearers in quiet times provided it was noted. He had taught his bearers to make a tourniquet out of a puttee and stick, and usually allowed them to put one on in the trenches provided the patient could undo it if causing too much pain. In a battle the regimental stretcher-bearers often have to put on splints. He thought that all aid posts should have a primus stove and that a thermos flask would be useful in an attack. He used moist dressings.

Lieutenant Sampson, R.A.M.C., was surprised that eusol had not been mentioned. He thought that if the dressings were sterile wet would be the best; if doubtful, dry. He asked Major Blackwood if he found the Page's splint for fracture of the arm satisfactory; he had found it painful, due to the method in which one had to produce extension by it. He himself had used a splint which produced extension of the humerus away from the body. He did not use saline in chest cases because it embarrassed the breathing, but in other cases it is of the greatest value. If tourniquets were used the reason for their application should be noted on a *tally*.

Colonel Dunn asked if salt tablets had been used. When he was at No. — General Hospital, Colonel Gray and Mr. Lockwood used salt tablets, especially for dirty wounds. It required experience to know the lightness with which to pack the gauze and tablets in the wound. A profuse flow of serum was started almost at once.

Lieutenant Sampson had talked with Colonel Gray a few days ago, and he had described the method of packing the wounds; he used gauze

soaked in ten per cent saline solution and, in the gauze, "tabloids" of saline. In the centre of the wound he put a large rubber drainage tube with lateral openings and he did not mind how long it remained, even up to nine days in some cases. The wounds he described were not recent ones. At field ambulances sloughs would form round the wound. When a case reached the base sloughing has occurred and can easily be cut away, but early on it is difficult to know how much muscle, etc., in a wound is going to slough; however, he thought the idea a good one, but whatever treatment was tried it ought to be done all the way down the lines of communication to have a correct idea of its utility.

Captain Moir, R.A.M.C.: When I was with the — Field Ambulance we tried salt tablets, but the patients complained so much of the pain that it was necessary to give up the treatment.

Captain McNee wished to know where, and how much, antitetanic serum was given. He had been able frequently to cultivate the bacillus from wounds where there were no signs, etc., of tetanus. He wished to point out that hot-water bottles applied over moist dressings would cause burns.

Major Alderson pointed out the value of many-tailed bandages in wounds of the lower limbs.

Lieutenant-Colonel Soltau: The paper read represented our work for fifteen months out here. He described two cases where damage was done by the application of a tourniquet. He had used chlorinated solution. *Re* the saline tablet treatment, it had been considered, but owing to the amount of discharge and the sodden state of the patient it was more suitable for down the line than in a field ambulance. The length of time between each dressing that may occur would possibly allow of the introduction of sepsis.

Major Blackwood (replying): Up to the beginning of the winter 1915-16, 1,500 units of antitetanic serum were used, but since then 500 and in some cases 1,000. The injection was given at the field ambulance. Page's splint did tend to rise at the shoulder, but it could be kept down a little by tapes across to the other side of the body. It would be a good plan for medical officers of field ambulances to do duty at the base for a time in order to observe the later conditions of wounds. One objection to chlorinated solution was that it required frequent changes, redressings, and, therefore, not so suitable in a field ambulance.

Colonel Bruce Skinner remembered that after the Franco-Prussian War every surgeon was going to do away with the ordinary bandage for splints and adopt the many-tailed, and McCormick after the Russo-Turkish War said the same. He had used strips of bandage over splints as a student, and he still considered it better than using a whole one. He read the introduction to Sir Almroth Wright's "Memorandum on the Employment of Vaccines in connexion with Wound Infections." The

wound could be packed with salt tablets and not dressed again until the base is reached, and as the flow is from the wound to the surface it is difficult to see how infection of the wound can take place. He wished to bring attention to:—

(1) The training of stretcher-bearers; they must be repeatedly taught, not only a series of lectures and then finish.

(2) The very ingenious sterilizer exhibited, pointing to the desire felt for sterilizers in a field ambulance.

(3) The bed-socks exhibited were presented by the Corps Commander.

(5) Primus stoves had been allotted for some time to aid posts.

Clinical and other Notes.

THE TREATMENT OF AMŒBIC DYSENTERY CARRIERS.

Note on the Use of the Double Iodide of Emetine and Bismuth.

By H. H. DALE, M.D., F.R.S.

(Department of Biochemistry and Pharmacology, Medical Research Committee.)

The treatment of entamœbiasis in this country, during the past year, has been largely concerned with the problem of freeing the chronic "carriers" from their infection. Experience in Egypt, in dealing with patients who continue to pass cysts after the dysentery has completely cleared up, seems to have led to the conclusion that a full course of ten or twelve grains of emetine hydrochloride, given hypodermically, will practically always eradicate the infection. The experience in this country, to judge from hospital records which I have had the privilege of seeing, does not altogether tally with this; for there seems to have been a not inconsiderable proportion of cases in which such a course of emetine may, indeed, have led to a temporary absence of cysts from the fæces, followed, however, by an early recurrence. These cases, relapsing into cyst-passing again and again after successive courses of emetine, have presented a difficult problem to the medical officers in charge of them. Their frequent occurrence among the cases treated here was to be expected, for these consisted largely of cases which had undergone relapse into chronic "carrying," after apparently successful treatment of their acute infection with emetine; others had probably never been freed, by repeated dosage with emetine, before their return to this country; while others again were apparently "contact carriers," with no history of previous dysentery or treatment. It was clearly a matter of importance that these men should be freed from the danger to themselves, and to others, entailed by the persistent focus of infection.

The pathology of the chronic carrier of *Entamœba histolytica* seems to be still imperfect, in that it has not been definitely ascertained whether the cyst-producing entamœbæ are living freely in the intestinal contents, like *E. coli*, or are localized in a partly healed pocket or sinus. The occurrence of liver abscess without acute dysentery seems to favour the latter supposition. In either case the relative failure of hypodermic treatment with emetine, in this condition, could be explained by the entamœba being more or less completely shut off from the circulation and tissue fluids of the patient. The alleged superior efficacy, in these cases, of the other treatment with ipecacuanha by the mouth, is in line with such a conception. By these considerations I was led to suggest a trial in cases refractory to hypodermic emetine, of oral administration of

emetine, in a form which gave promise of combining the advantage of the ipecacuanha treatment with freedom from its notorious difficulties and drawbacks. The results have been so far promising, that it seems worth while in the interests of a wider trial, to make mention of them at their present stage of incompleteness. The compound which has been used is a double iodide of emetine and bismuth, which was described last year by Du Mez, who suggested it as suitable for oral administration of emetine. It has the useful property, from this point of view, of being practically insoluble in dilute acids, but soluble with comparative ease in weak alkali. It might be expected, therefore, to pass the stomach unaltered, and then being dissolved in the alkaline juices of the duodenum, to undergo gradual decomposition as it passed along the bowel, with liberation of emetine and precipitation of bismuth sulphide. Du Mez obtained promising but rather irregular results on dogs to which he gave the compound. So far as I have been able to ascertain, it has not hitherto been tried clinically.

My colleague, Dr. Barger, prepared me a sample of this double iodide and I tested it, in the first place, on cats. I found that large cats weighing upwards of 3 kilograms could take repeated doses of 40 milligrammes without vomiting, the only effect being some looseness of the bowel. Sixty milligrammes (containing about 20 milligrammes of emetine) produced vomiting; but the fact that this occurred some five hours after the administration, while purgation occurred about 1½ hours after the drug had been given, indicated that the vomiting was not due to direct irritation of the stomach, but was secondary to liberation and absorption of emetine in the bowel, and therefore comparable to the vomiting which follows a large hypodermic dose. If treatment with these larger doses was continued, the symptoms of chronic emetine-poisoning, which I have previously described, made their appearance as with hypodermic administration.

Messrs. Burroughs Wellcome and Co. kindly placed at my disposal a quantity of the compound for preliminary clinical trial, and further quantities were made to the order of the Medical Research Committee. The first trial was made at the Graylingwell Military Hospital, Chichester, by kind co-operation of Lieutenant-Colonel A. H. Kidd, Major Maxwell and of the other medical officers in direct charge of the patients, and of Messrs. Geoffrey Paget and W. Redman King, who made the protozoological examinations. Mr. King has kindly furnished me with a résumé of the results on ten patients, all of whom had repeatedly shown early recurrence of cyst-passing after courses of hypodermic emetine. Of these patients, six have already been discharged as cured, having failed to show any histolytica cysts, with stringent daily examination of the fæces during six weeks following a full course of the double iodide by the mouth. Two of these cases have not much evidential value, since the double iodide treatment was started while cysts were still absent, as the

immediate result of a hypodermic course. The other four are open to no such criticism. A seventh case relapsed after a full course of the double iodide, but, after a second course, has been free from cysts for four weeks, so that his permanent cure is probable. The eighth case has been unable to stand a full course owing to nausea, but cysts have been absent for some time, with administration on alternate days, so that the result is hopeful. There remain one case in which relapse has occurred after two full courses, and one in which the treatment could not be continued owing to the vomiting and diarrhœa which it caused.

Bearing in mind the fact that the cure of these patients had been practically given up as hopeless, with the ordinary hypodermic emetine-treatment, and that the standard of cure demanded—six weeks absence of cysts, with daily examination—was a very high one, the results must be considered promising. Some trouble occurred, in some cases, from vomiting; but this was overcome in most instances. Administration during or just after a full meal seems to have been the best method for avoiding vomiting, probably owing to the acidity of the stomach contents at this time. Some patients, who were reported as vomiting with the first doses, seemed to acquire a tolerance subsequently. The fact that the vomiting if delayed probably means that most of the dose is in the intestine before it occurs, so that the comfort of the patient is affected more than the efficacy of the treatment. Thirty to thirty-six grains, equivalent to about ten to twelve grains of emetine-hydrochloride, has been regarded as a full course, and the daily dose has varied from two to four grains, given in capsules. Three grains, representing one grain of emetine-hydrochloride, seems to be a good average daily dose, and twelve such doses may be given in succession, unless giddiness, depression or diarrhœa become severe. The frequency of vomiting is in no way comparable to that seen with the ipecac. treatment, and there is no need as a rule to restrict diet, to keep the patient recumbent, or to adopt the precautionary measures which the ipecac. treatment entails. The daily dose suggested, of three grains of double iodide, is equivalent in emetine to some sixty grains of ipecacuanha.

Several other cases, privately treated, are still under observation, but the results, which Dr. G. C. Low and others have kindly communicated to me, are similarly promising. A further trial is in progress at another military hospital, through the kind interest of the Commanding Officer, and of Mr. C. C. Dobell who is responsible in this instance for the protozoological findings. One fresh case of acute dysentery has been treated by Dr. Low with daily doses of three grains of the double iodide, with results apparently as good as those of the hypodermic emetine treatment. If it be a fact that the residual infection, with healing ulceration, is more accessible to the emetine given by the mouth, it may be worth while to consider whether the later doses of the usual course of emetine, given in an acute case, would not, with

advantage, be given as the double iodide. It seems possible that the risk of subsequent "cyst-carrying" might thus be diminished. The possibility of using the emetine-bismuthous-iodide prophylactically seems to me also well worthy of consideration. I believe that most men could take a grain or so every few days, without any notable effect on health, comfort, or efficiency. I am having some tablets prepared, keratin-coated, as an additional safeguard against vomiting, and will try them on some normal subjects in the first instance. Experience would have to show how small and infrequent a dose would give protection to those exposed to the chance of being infected. A drawback to the wide use of the compound, as a wholesale prophylactic, would, under present conditions, be the expense entailed. The ordinary emetine salts are expensive enough, and the extra trouble of making the double iodide will presumably make the latter, dose for dose, even more costly, though the difference should not be very large.

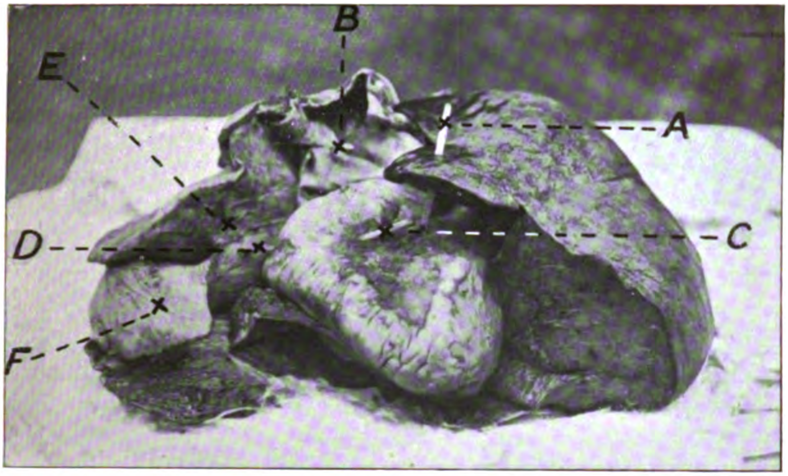
My best thanks are due to the gentlemen above mentioned, who have interested themselves in the trials recorded, and to others who are giving their co-operation in those still in progress.

NOTES ON A CASE OF PENETRATING WOUND OF THE HEART.

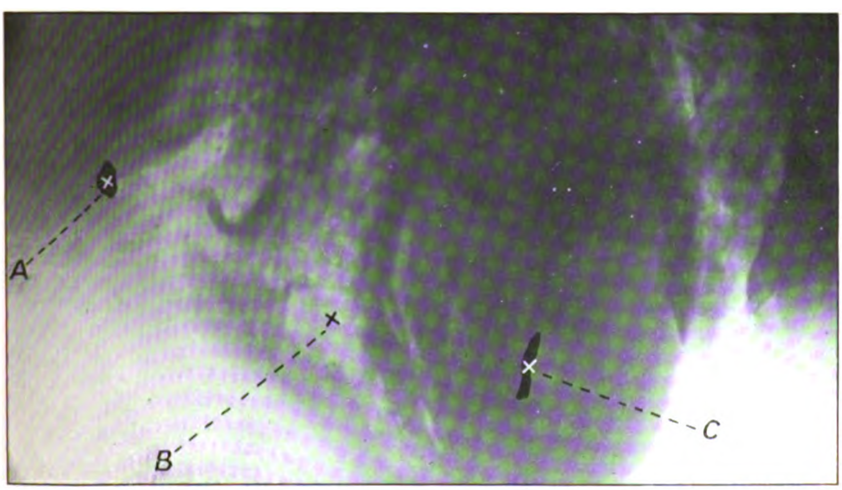
BY CAPTAIN R. GARSIDE DIXON AND CAPTAIN P. McEWAN.
Royal Army Medical Corps (T.F.).

THE following case is the only example of a wound of the heart in a series of 123 wounds of the thorax and its walls which have passed through this casualty clearing station during the last ten months. The great majority of penetrating wounds of the lungs have progressed sufficiently well to be sent to the base, and it is a recognized fact that most of these cases ultimately recover. Probably nearly all cardiac wounds produce death from hæmorrhage too quickly to allow of their being removed alive even to a short distance from the battlefield.

In the case recorded here the patient was wounded whilst in the upright position by a rifle grenade at 12.15 a.m. on March 23, 1916. He was admitted to this hospital the same day at about 7 p.m. with a diagnosis of "gunshot wound of chest and right arm, compound fracture left elbow." His tally showed that he had had hypodermic injections of antitetanic serum (500 units) and of morphia ($\frac{1}{2}$ grain) at the field ambulance. On admission he was cold, suffering very severely from shock, short of breath, and cyanosed, but his lips were pale. Temperature, 101° F.; pulse, 112; respiration, 28. He was too ill to have his



A. Probe through wound in Left Lung.
B. Probe through two wounds in Pericardium.
C. Probe through entrance wound in Right Ventricle.
D. Probe through exit wound in Right Ventricle.
E. Piece of metal in Right Lung.
F. Wad of cotton wool to evert margin of Right Lung to show piece of rifle grenade.



A. Piece of metal in Right Lung.
B. Empty Right Ventricle.
C. Tinfoil along course of Coronary Artery.

To illustrate "Notes on a Case of Penetrating Wound of the Heart," by Captain R. GARSIDE DIXON, and Captain P. MCEWAN, R.A.M.C. (T.F.)

wounds dressed, but with brandy salines and hot-water bottles he improved sufficiently to have this done the following morning. His left arm, which was fractured, was transferred from a straight splint to a Thomas's, and the wound of his right arm, which was slight, was dressed. There was a small wound ½ inch to the inner side and ½ inch above the left nipple. A catheter was passed, and about a pint of normal urine drawn off. The patient was still very short of breath, and the dressing of his wounds was as much as his condition would permit of. At 2 p.m. his pallor increased, he became more cyanosed, and his breathing more difficult. His temperature rose to 102° F.; pulse, 130; respiration, 45. At 6 p.m. ¼ grain morphia was given hypodermically to relieve the distress caused by the shortness of breath. He was semi-conscious all the time he was in this hospital. He knew his name, regiment, and home address, but kept on trying to get out of bed, and was often delirious. He never complained of any pain either in the chest or arm, but suffered considerably from thirst. The heart sounds were normal. There were signs of fluid in both pleural cavities, more on the right than on the left side. There was neither cough nor expectoration. The cyanosis deepened, the pallor and dyspnœa increased, and he died at 11.45 a.m. on March 25, thus having lived fifty-nine and a half hours after receiving the injury, and having during that time been conveyed from the regiment to the field ambulance, and from that unit to this clearing station.

The body, which was examined four hours after death, before the onset of *rigor mortis*, was that of a well-built man of medium height and good muscular development. The skin was pale, but cyanosed, and there were no wounds other than the three already mentioned. The wounds of the left elbow and right arm were of no pathological interest, and could not have been factors of any importance in causing death. A small external wound, situated just above and internal to the left nipple, was traced transversely inwards for about two inches through the subcutaneous tissue and chest muscle; its subsequent course was through the sternum, leaving the internal mammary artery intact; then through the edge of the left lung, the pericardium, the right ventricle, the pericardium, and finally the missile was found lying embedded in the right lung. It was not removed for examination, but its small size can be judged from the X-ray photograph.

The left pleural cavity contained a considerable quantity of blood, but the lung was of nearly the normal size; the right pleural cavity was almost full of blood, and the lung was found to be collapsed. The blood was fluid except for a single clot on the right side. The left lung had a slit-like wound of entrance, detected with difficulty, ½ inch from the margin, at the inner and lower part of the anterior surface of the upper lobe, and a larger wound of exit through the margin of the inferior surface; about ½ inch of the lung tissue had been passed through. There was a patch of recent fibrinous pleurisy between the upper and

lower lobes extending for about two inches on to the anterior surface of the lower lobe. On the under surface of the middle lobe of the right lung, about ½ inch from the inner margin, a small piece of metal could be seen lying in the lung substance. There was no recent pleurisy, but the upper and middle lobes were almost completely fused by dense old adhesions.

The pericardium showed an entrance and an exit wound over the right ventricle. On opening the sac a small piece of khaki cloth was found, together with a small quantity of clotted and fluid blood. The pericardium had the appearance of an early pericarditis. The left ventricle was distended, but the right was partially collapsed, and near the centre of its anterior surface was a small circular wound of entrance, which passed obliquely through the muscle to a wound of exit very near to the right border of the heart; an interval of an inch separated the two wounds, and round each was a small circular area of bruised tissue. The right ventricle was opened posteriorly and found to contain some very bright red blood-clot. No wound was visible from the interior, and on passing a probe, it was found that the wound passed through one of the lacunæ between the pillars of cardiac muscle, having just penetrated the ventricular cavity.

The cause of death was severe hæmorrhage, complicated with pulmonary collapse and interference with the heart's action. The enormous amount of blood in the pleural sacs came from the heart, the lung wounds were not capable of causing much hæmorrhage. With each systole some blood would be forced through the small openings in the right ventricle into the pericardial sac, and from there blood would ooze through the pericardial openings into the pleuræ. There was no attempt at closure of the openings by clot. Their small size accounts for the length of time the patient survived.

The occurrence of pericarditis and pleurisy (the latter being curiously localized) showed the beginning of an infective process.

The wounds of the left lung were, no doubt, closed by blood-clot, while that of the right was kept open by the shrapnel on the surface, causing collapse.

An X-ray photograph of the specimen was taken by Captain F. H. Gibson, R.A.M.C., and no foreign body other than the one described was found.

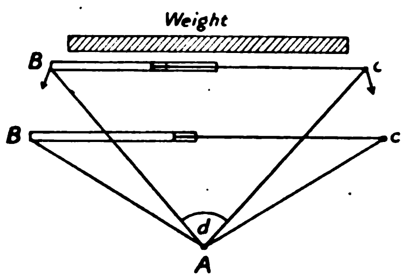
The specimen has been sent to the War Museum of the Royal College of Surgeons, London.

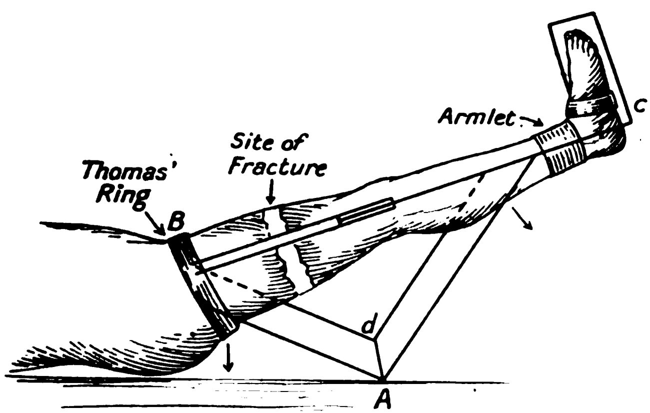
AUTOMATIC EXTENSION LEG SPLINT.

BY CAPTAIN T. WARRINGTON.
Royal Army Medical Corps (*S.R.*).

THE principle of this splint is that the weight of the leg is utilized as the extending force.

If one imagines a triangle, ABC, made of thin iron rods, with the side, BC, extensible and hinge joints at ABC, when the triangle is resting on A it is obvious that any weight resting on BC will tend to increase the angle A and therefore extend the side BC. Thus, if a fractured limb rests on BC, with the two ends fixed at B and C





respectively, the weight of the limb will increase the angle A and the distance BC till the muscular tension prevents further extension, and as the muscular tension is proportional to the strength and size of the muscles, and, therefore, to the weight of the leg, the amount of extension produced is approximately the amount required, and decreases automatically as the muscles waste and their tone and weight diminish. In this way over-extension, which obviously blocks the lumen of small

and valuable capillaries and lymphatics, both by lateral pressure and longitudinal tension, especially at the site of fracture, tends to be avoided.

The details are as follows:—

The splint is composed of a Thomas's knee splint frame, telescopically extensible. The upper end is fixed to the leg by a half Thomas's ring, and it is fixed below the fracture by an anklet bandage, or slung in the usual manner, and the limb supported at the seat of fracture by perforated zinc or lint, and the splint is supported by two hoops of iron forming a **V** and connected to each other and to the splint by hinged joints. One arm of the **V** is connected above, the other below the seat of the fracture. The weight of the leg tends to increase the angle of the **V** and thus extension is obtained.

The advantages of this apparatus are :—

(1) There is no need to move the limb or splint in slightest degree for dressing or irrigation.

(2) Easy access obtained to all parts of leg.

(3) No absorbent dressings are needed; any discharge can be caught in a dish placed underneath.

(4) Extension decreases as muscles waste.

(5) Extension simplified in the presence of sores or cellulitis.

The same splint is applicable to most fractures and any length of leg, and to lift the patient the whole thing can be made a single unit by fixing the telescopic extension by a screw, and in a similar way the height of the leg from the bed can be adjusted. If additional extension is desired, hang weights on the end of the splint. The disadvantages are that it cannot be used on a full water-bed or if the knee is desired flexed.

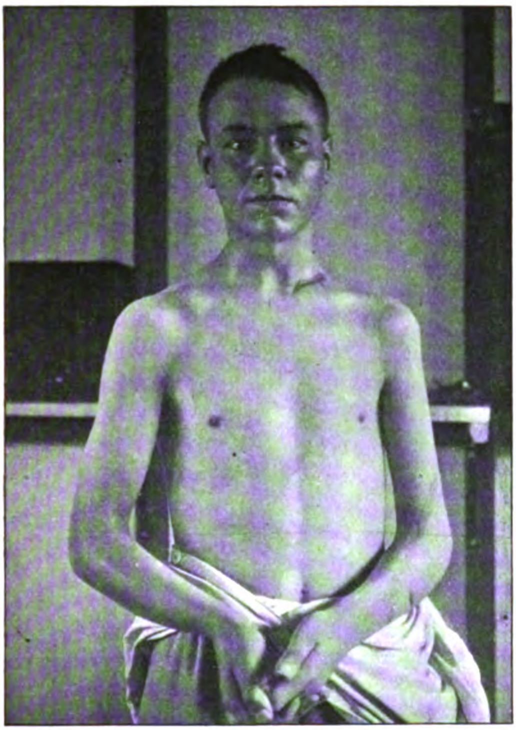
SHRAPNEL WOUND INVOLVING THE BRACHIAL PLEXUS, TOGETHER WITH THE VAGUS, SPINAL ACCESSORY AND PHRENIC NERVES OF THE SAME SIDE.

By Captain FFRANGCON ROBERTS.
Royal Army Medical Corps.

Rifleman R. was admitted to this hospital last summer, having been wounded by shrapnel on May 22. There were two wounds in the neck; one, stated to be that of entry, was situated at the sternal end of the left clavicle; the other, presumably an exit wound, was situated 2½ inches to the left of the middle line behind at the level of the spine of the fifth cervical vertebra. The anterior wound was discharging, the posterior was healed.

There was loss of power of external rotation and abduction of the humerus and of flexion and supination of the forearm, while the movements of the scapula were limited. Further examination showed com-

plete paralysis of the spinati, biceps, deltoid, supinator longus; partial paralysis of the trapezius, rhomboids, levator anguli scapulæ and flexors of the wrist and fingers. All the above muscles were wasted. The spinati, rhomboids, deltoid, biceps, and supinator longus gave no reaction to the interrupted current and a sluggish response to galvanism. Stimulation of Erb's point in the neck caused no contraction of the above muscle. The upper fibres of the trapezius also showed signs of degeneration.



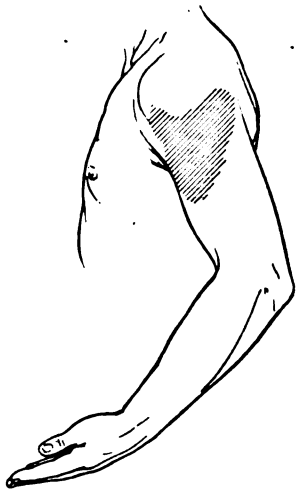
The wound of entry is shown at the inner end of the scar; wound of exit behind. Note wasting of trapezius, deltoid, biceps and supinator longus.

There were few sensory changes. The patient complained of shooting pain along the front of the upper arm, chiefly at night. Occasionally he felt pins and needles in the hand; this was relieved on rubbing the hand. There was a small area over the deltoid which was deficient in the appreciation of pin-prick and of fine shades of temperature. The borders of this area were variable.

That there was some affection of the vagus was first suggested to us by the patient's hoarse voice and constant dry cough, which he said he

had complained of ever since he was wounded. An examination of the larynx by Captain Murphy showed that the left vocal cord was paralysed in the cadaveric position. On phonation the right cord came over the mid-line to meet the left. A second examination a few months later showed that slight movement had returned in the vocal cord. The cough slowly disappeared and the hoarseness became less marked. There was nothing abnormal in the pulse so far as we could ascertain.

The condition of the phrenic nerve was investigated by observing the movements of the diaphragm under the X-rays. The two sides showed a marked contrast. While the right cupola performed the normal respiratory excursions, the left on normal respiration appeared to remain



Loss to pin-prick and fine shades of temperature. Feels cotton wool and discriminates extremes of temperature. The border of this area is very indefinite and variable.

motionless, while on deep inspiration it moved slightly upwards, apparently owing to the increased abdominal pressure. It was interesting to note that in spite of the complete paralysis of one half of the diaphragm, the rate and rhythm of respiration were normal; there was no dyspnœa even on exertion.

The X-ray examination revealed incidentally yet another point of interest. Lying near the left border of the heart and moving with each beat was a foreign body about the size of a pea. As there was no wound in the thorax one must assume that a small fragment had migrated from the neck.

When the anterior wound had completely healed, an operation was performed by Major H. B. Roderick. The fifth cervical root was found

to be completely severed, while the surrounding parts, including the junction of the fifth and sixth roots, were involved in cicatricial tissue. The ends of the fifth root were trimmed and united and the adjoining parts cleared of scar tissue. A search was then made for the spinal accessory. The central end was found to terminate in the scar tissue, This was dissected out and the end trimmed. As no trace of the peripheral end could be found the central end of the nerve was inserted into the trapezius and sutured in position.

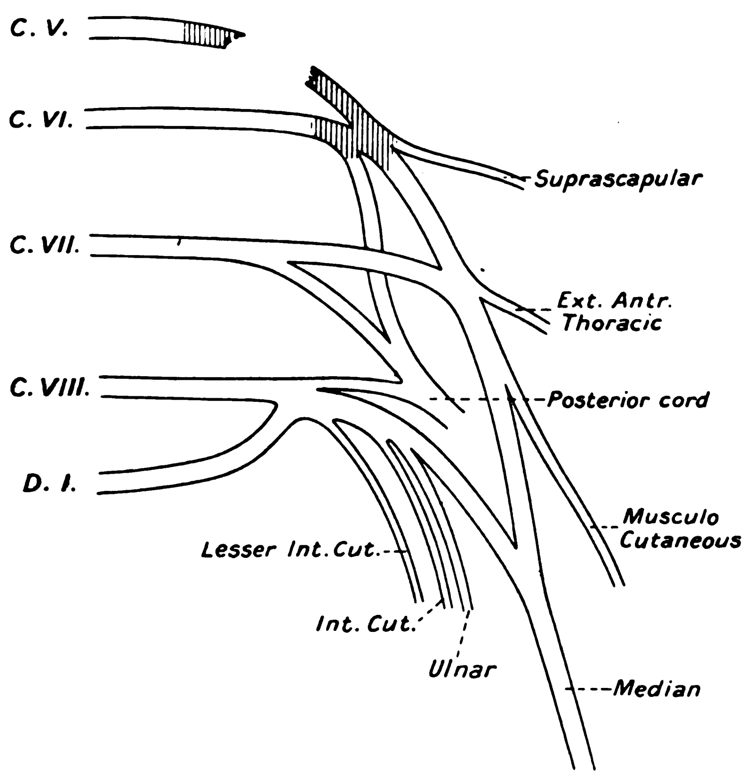


Diagram of brachial plexus showing site of injury ; the shaded part is that which was involved in scar tissue.

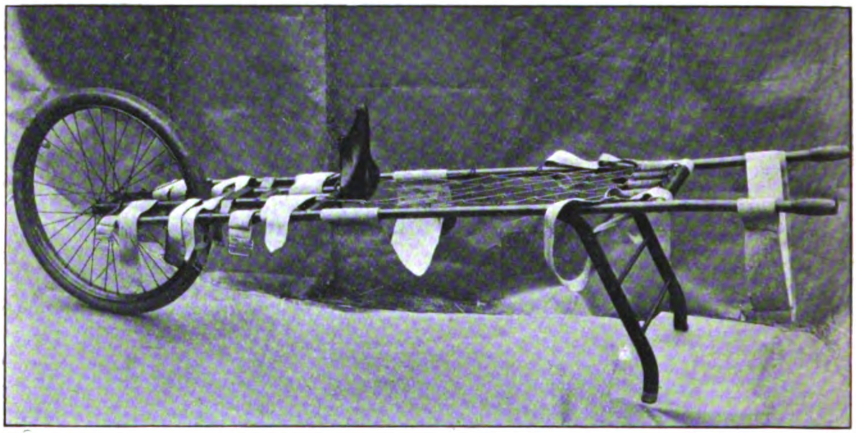
Such an injury to the brachial plexus is not uncommon. In ten months' neurological work I have come across four cases, in two of which an operation was performed. A similar injury occurs occasionally in obstetric manipulations, when it is known as Erb's palsy. Sherren states that the fifth cervical root supplies the deltoid, rhomboids, supinator longus, spinati and biceps. In the second case which I have seen

operated upon (under the care of Lieutenant-Colonel Deighton) the fifth root only was involved (constricted by scar tissue). In this case the biceps, though completely paralysed at first, soon recovered, its power being almost normal before the operation. These two cases would thus seem to show that a large proportion at least of the fibres to the biceps come not from the fifth but from the sixth cervical root.

A TRENCH CYCLE STRETCHER.

By Captain R. KENNON.
Royal Army Medical Corps.

The evacuation of wounded from the trenches is fraught with so many difficulties that even when "all is quiet" occasions arise that permit of their removal only under cover of darkness. In addition to the length and irregularities of the communication trench, it is frequently necessary to expose the patient and bearers to full view of the enemy when negotiating a difficult traverse. It was in such trenches, and before the issue of the short trench stretcher, that Captain Jeavons and myself



cast about for some means of minimizing the exposure and obtaining rapid evacuation by daylight in the trenches we then occupied. Our ideas were materialized by Messrs. J. H. Brookes, of Birmingham, who produced the Victor stretcher. Reference to the accompanying photograph will readily explain its features, the keynote being an ordinary cycle saddle upon which the patient sits strapped to the stretcher whilst he is pushed wheelbarrow fashion round the most intricate traverse. The main advantage is the economy of time and labour. Whereas formerly a party of five or more men were required for each patient, two

or three bearers could now do the same journey in half the time, and wherever the wheel caused obstruction it could be detached and the framework used as an ordinary stretcher adjustable by sliding foot-rests to the size of the patient. The onset of wintry weather severely tested the machine and revealed one or two defects, which doubtless will be removed in later patterns. The weight of the patient is a little too far behind the wheel, so that the stretcher tends to shoot forwards. Again, on narrow uneven trench boards skidding is liable to occur; to obviate this we have called to our aid the battalion pioneer, who has forged a crude bath-chair handle loosely clamped round the footrest to steady the wheel.

SIMPLE HEAD-REST, ADAPTED FOR USE WITH THE ORDINARY REGULATION ALUMINIUM OPERATING TABLE.

By Major H. T. WILSON.
Royal Army Medical Corps.

The following description of a head-rest kindly made in the workshops of No. 8 M.A.C. has been most useful in the casualty clearing station here, and might be of use to other units.

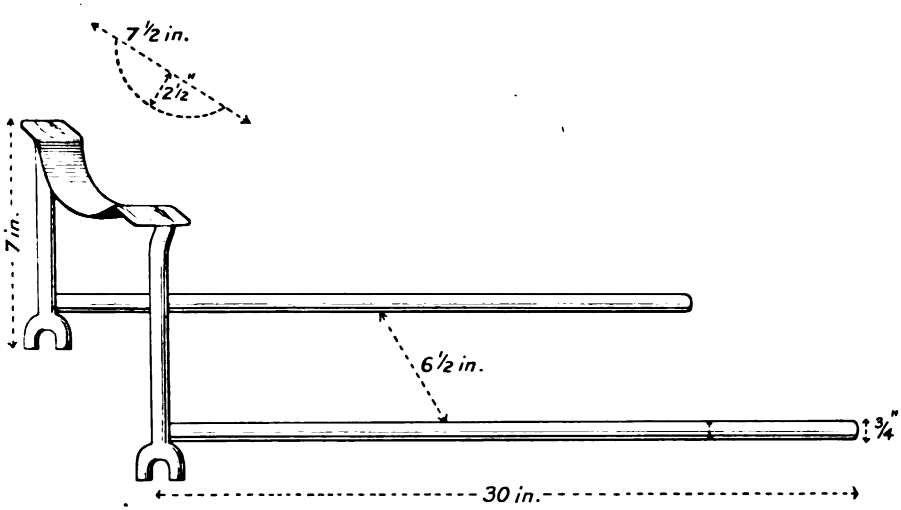


Fig. 1.—Head-rest.

It is made of rod iron ¾ inch in diameter with a thin iron plate curved to receive the head welded on to it; the dimensions are as per fig. 1. The ends of the long rods may be hooked so as to catch one of the cross-rods of the table, but as the tables vary slightly in dimensions,

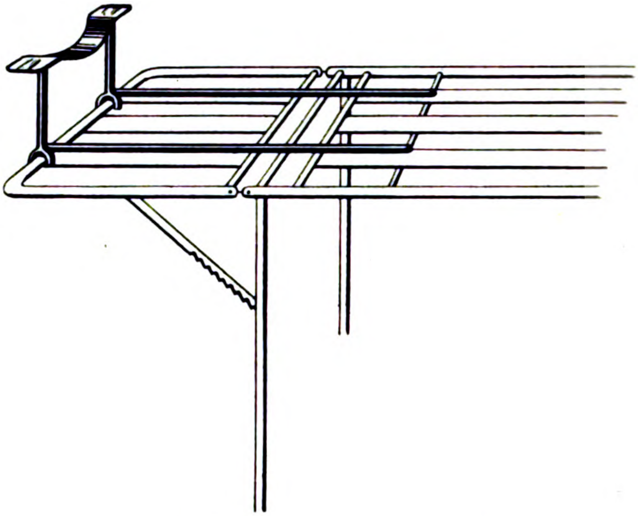


FIG. 2.—Head-rest fixed for head cases.

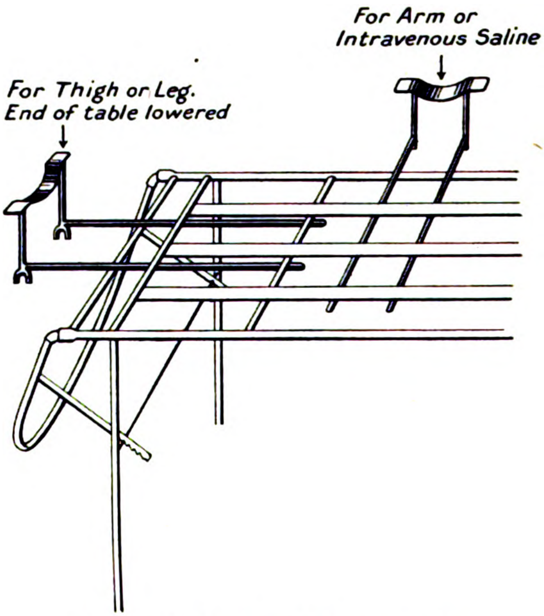


FIG. 3.—Head-rest used for arm or leg.

if this is done it will only fit that particular table, whereas the weight of the patient on the rods is quite sufficient to keep the rest firm, and the rest will do for any table. The device is easily made in any smithy of an armourer's shop or mechanical workshop.

For head cases it is fixed to the end of the table as per fig. 2 and in occipital cases gives the anæsthetist more scope than he usually has in such cases.

It may also be used for amputations of the leg, thigh and arm, being fixed as per fig. 3, and is also quite useful for supporting the arm while an intravenous saline is being given.

SILVER-WIRE DRAINAGE TUBES.

By Captain P. N. VELLACOTT.
Royal Army Medical Corps.

These tubes are made in sizes from 2 inches by ¼ inch to 8 inches by ¾ inch. They are made entirely of silver wire, soldered, and fine in the small, thick in the larger sizes. They are cylindrical, open at one end, and bluntly pointed at the other. The following advantages over rubber tubes are claimed for them :—

(1) They give more effective drainage, being incompressible, and admitting discharges more freely throughout their whole length. Rubber tubes are often compressed and bent by the swelling tissues, and their lumen thus blocked. The tissues in contact with the spaces between the holes cut in a rubber tube are not freely drained, and discharge may collect at these sites.

(2) Atmospheric or applied oxygen, and irrigating fluids such as peroxide lotion, come more directly in contact with the tissues than when rubber tubes are used.

(3) They can be repeatedly used, and although their initial expense is greater, it is by no means prohibitive.

Reviews.

THE PATHOLOGY OF TUMOURS. By E. H. Kettle, M.D., B.S.Lond. London: H. K. Lewis and Co. 1916. Pp. viii and 224. Price 10s. 6d. net.

The volume under review is a convenient sized handbook of 224 pages and 124 illustrations. It gives briefly and clearly all the principal features bearing on the pathology of new growths. It is divided into three parts: Part I deals with the general biology of tumours, embracing their etiology, structure, mode of growth and dissemination, and a chapter dealing with the experimental study of cancer is also included. With regard to diagnosis the author issues a warning against relying upon the so-called "rapid diagnosis" by frozen sections during operation, and we are sure most pathologists of experience will endorse his views. Part II is devoted to the general pathology of tumours, and contains detailed descriptions of all the different neoplasms. Part III is concerned with their special pathology and describes the various new growths as they are met with in the individual organs and tissues of the body.

The book is evidently intended for those taking up the study of pathology rather than the advanced worker, and the descriptions follow strictly the generally accepted teaching.

The student preparing for his examination could have no better book to give him a sound knowledge of this important part of pathology. It is excellently written, clear and sufficiently full, and the illustrations are a special feature of the work. They have been specially drawn from microscopical preparations and are beautifully reproduced. The illustrations of naked-eye specimens are not quite so good as the others, and we think the author might improve upon them with advantage.

A. M. K.

I.K. THERAPY IN PULMONARY TUBERCULOSIS. By William Barr, M.D., D.Sc., D.P.H. Published by John Wright and Sons, Ltd., Bristol. 1916. Pp. 82. Price 3s. 6d. net.

In comparison with tuberculin, very little has been heard in recent years concerning Spengler's I.K. (Immunnkörper) and the dearth of literature on the administration of this preparation in pulmonary tuberculosis makes Dr. Barr's little book particularly welcome.

Dr. Barr is a thorough optimist on his subject and holds the view that I.K. is valuable in practically every form of phthisis; moreover, he considers that there are but few limitations to its use. However his views may be modified by further experience, he has certainly proved that I.K. is entitled to a fair trial, and the guidance in methods of administration contained in his book is ample to enable any physician to try the remedy in his own practice.

To the tuberculosis expert, who has hitherto confined his specific treatment to the various tuberculins, this book will prove an excellent introduction to I.K. therapy.

Dr. Barr deals with both the subcutaneous and oral methods of administration, but it would have been better if he had more fully proved his case for the oral method.

The lytic reaction following an injection of I.K. is ascribed as being due to the too great destruction of bacteria by the bacteriolytic component of the I.K., giving rise to toxins far in excess of the antitoxins available in a given dose.

It is much to be desired that this hypothesis is correct, but no proof is offered so we must still believe that the reaction, like the tuberculin reaction, is due to inflammation and increased vascularity at the focus of disease, which allow toxins already in the lesion to escape in the blood-stream more plentifully.

If reactions indicate great destruction of tubercle bacilli such results should be welcome, for the original cause of the disease would thus eventually be removed; Dr. Barr, however, states that severe reactions must be viewed with alarm.

The valuable information given on the difficult subject of hypersensitiveness will be a real help to the beginner, who frequently finds this condition his greatest stumbling block.

Treatment both by the gradual and rapid method of dosage is dealt with, but the gradual method is very wisely recommended as the safer and more reliable.

The tables and charts at the end of the book have been carefully prepared and contain much practical information regarding difficulties one is likely to come across.

Although the author writes strongly in favour of I.K., he readily acknowledges that it will not entirely replace tuberculin and recognizes that the latter drug will continue to hold its own when once its indiscriminate use has disappeared.

Hitherto, with few exceptions, specific treatment of tuberculosis has been confined to specialists, but the advent of I.K. opens the field for the general practitioner. Relative to tuberculin it is simple in its application and, if the first principles of I.K. therapy, as clearly laid down in the admirable little book under review, are carefully studied, there seems no reason why good results should not be obtained in general practice.

"A Pocket Medical Dictionary," 35,000 Words. By G. M. Gould, A.M., M.D. London: H. K. Lewis & Co., Ltd., 1915. Seventh Edition, revised. Price 5s. net.

A neat, clearly printed and well bound pocket volume. A general survey gives the impression that the definitions are accurate and upon the whole sufficiently clear, though in some instances there is a certain vagueness, such as—"Muscular Bundle of His, a neuro-muscular band joining the right auricle to the ventricle in the mammalian heart"; and again—"Murmur, a low sound heard in auscultation." There are useful tables of bones, muscles, nerves and micro-organisms.

The book concludes with a "Physicians' Dose Table," of official and some non-official drugs (the doses being rendered in both apothecaries' and metric systems), which would be improved by a better arrangement of the preparations, and if a wider range of doses were given; and a

veterinary dose table, giving suitable doses for horses, cattle, dogs and sheep. The book can be recommended as a practical "vade mecum" for the student and practitioner. J. G. D.

"THE ROLLER BANDAGE." By Howard M. Preston. London: T. Fisher Unwin and Bale, Sons and Danielsson, Ltd. 1916. Pp. viii and 112. 161 illustrations. Price 1s. net.

This little manual gives a good and clear account of the subject. It is well illustrated, and points of practical importance are insisted on. Most of the traditional methods of applying a roller bandage are described, but there are two notable omissions: no instructions are given for bandaging a stump, and no bandage for retaining a dressing on the neck is mentioned. These are two of the most important and most difficult applications of the roller bandage, and it is to be hoped that in future editions their omission will be made good. C. G. S.

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Original Communications.

INOCULATION AND INFECTIVE AGGLUTININS DETERMINED BY ABSORPTION METHODS.

BY I. WALKER HALL, M.D.

Professor of Pathology in the University of Bristol; Honorary Consulting Pathologist to the Second Southern General Hospital.

WITH THE ASSISTANCE OF I. L. HILES, M.SC., AND F. NICHOLLS.

SINCE the days when it was first realized that in certain diseases recurrence was unusual and Jenner was applying this knowledge to preventive inoculation against infection, many problems associated with the why and wherefore of immunity have called for solution. Not the least of these is the relation between the immunity obtained by prophylactic measures and that conferred by disease. Some of the bypaths of this question seemed to open up during routine examinations recently carried out on cases of paratyphoid fever, and it may be of value to others if we record shortly some of the glimmerings we have seen and the failures we have met with.

For the diagnosis of bacillæmia and intestinal infection it is customary to culture the blood and excreta, with the object of isolating the infective micro-organisms. In many instances, however, these processes cannot be carried out, owing to the distance of the patient from a laboratory, and the opportunities for repeated examinations, etc. Estimations of the agglutinin content of the blood serum are then resorted to.

Although there are fallacies associated with several of the

methods employed for demonstrating the presence of typhoid or other agglutinins in serum, the value of the results when interpreted by experienced workers is too well known to call for comment. The introduction of preventive inoculation against typhoid fever has added additional factors and possibilities of fallacy, many of which are still the subject of inquiry.

The extension of preventive inoculation to include paratyphoid A and B infections, as well as cholera, etc., must bring about an appreciable alteration in the antibodies of the blood-serum, both in their amount and in their inter-relations. These interactions and their effects have formed the object of the work now recorded.

The return of subacute and convalescent cases of typhoidal fevers from the Front in the early months of the War called for some method of serological examination, whose results would support bacteriological findings, or in their absence serve as direct evidence of specific bacterial infection. The method was required to yield figures which could be used for the differentiation of inoculation agglutinins induced by the injection of dead typhoid or paratyphoid bacilli, and those produced in response to the irritant derived from living or dying infective organisms. For guidance in this selection we had the advantage of consulting the pioneer work carried out by many I.M.S. and R.A.M.C. workers in India, whose findings anticipated and foreshadowed much that has been observed during the War. We have been deeply indebted to these records and especially so to a valuable account by Harvey, covering the period 1908-1911. Later on, Dreyer, Ainley Walker, and Gibson, in February, 1915, proposed the application of Dreyer's agglutination test to these problems [3]. They urged the importance of classifying all cases returned as "enteric" in accordance with the results of bacteriological examinations. They advised the routine testing of the serum against several micro-organisms to its maximum dilutions. They stated that it would be found that the principal infective agent exhibits the highest agglutination titre, and that while the active agglutinin varies in its titre, the preventive inoculation agglutinin remains practically unaltered if several estimations are made within a fortnight.

In our laboratories, Dreyer's agglutination method has been in constant use since it was first published in 1906, when we abandoned the microscopical method, except for confirmatory purposes [1]. The results personally obtained agreed with those stated by Dreyer in the *Journal of Pathology* in 1909 [2]. In addition it had been used for comparative results during the con-

tinuous investigation of two typhoid carriers for over two years. The figures gained by the method had been made somewhat comparable by preparing quantities of emulsion sufficient to last for over a year, and standardizing the fluid by counting the bacteria and testing the agglutinin results against the previous batch. It was felt, therefore, that the workers were sufficiently acquainted with the method and its possible fallacies to apply it under War conditions.

The preparation of an emulsion had been commenced when the Medical Research Committee announced the production by the Oxford laboratories of a standardized emulsion, and offered it for general use. This arrangement made it possible for all results to be comparable during the War, and accordingly the Oxford standard preparation has been employed continuously in this laboratory.

Up to the end of May it has been applied in 1,058 cases, consisting of eighteen non-inoculated men, and 1,040 who had been definitely inoculated with *Bacillus typhosus*. The main results are as follows:—

NON-INOCULATED MEN (clinically considered as Enterics or Dysenterics).

No agglutinins present	5 cases
Typhoid agglutinins only	7 ,,
Typhoid and paratyphoid A agglutinins present	1 ,,
Para A agglutinins only	3 ,,
Para B agglutinins only	1 ,,
Para A and *B. Shiga* agglutinins	1 ,,
Total	18 cases

INOCULATED AGAINST TYPHOID FEVER (1,040).

Agglutinins absent	12
Typhoid agglutinins only	478
Typhoid and para A agglutinins	129
Typhoid and para B agglutinins	246
Typhoid and para A plus para B agglutinins	5
Typhoid and para A and *B. Shiga* agglutinins	6
Typhoid and para B and *B. Shiga* agglutinins	11
Typhoid and para A and B and *B. Shiga* agglutinins	1
Typhoid and para A and B and *B. Flexner* agglutinins	1
Typhoid and *B. Shiga* agglutinins	143
Typhoid and *B. Flexner* agglutinins	8
Total	1,040

These cases were drawn almost entirely from the Mediterranean area. Hence they were chiefly convalescents, examined for clearance purposes. There was, however, a sprinkling of acute cases sufficient to permit of the application of some critical experiments.

It has been our custom to examine the blood as well as the urine and fæces in these cases, and the serological results were found of value in pointing to a preferential method of enrichment prior to plating the excreta.

TECHNIQUE.

The blood was examined within twelve hours after clotting. The specimens were numbered as they arrived. One worker put up the test; another read off the results, and a third checked the results. The figures were then handed to a fourth who recorded the findings under their case headings. In this way, sympathetic readings were avoided. Following the usual directions, each estimation was made to a high dilution forthwith, with the necessary controls for each batch, so that repetition was necessary in a few instances only. The dilutions used for each test were as follows:—

SERUM DILUTIONS.

Killed bacillary standardized emulsions									Controls with N/saline
B. typhosus	25	50	125	250	500	1,250	2,500	5,000	1/25
B. paratyphosus A ..	25	50	125	250	500	1,250	2,500	5,000	1/25
B. paratyphosus B ..	25	50	125	250	500	1,250	2,500	5,000	1/25
B. dysenteriæ (Shiga)..	25	50	125	250	..	1,250	2,500	5,000	1/25 (*B. dysenteriæ Flexner*)

The completed test was then incubated in a moist atmosphere at 52° C. for four hours and allowed to stand overnight in order to ensure complete agglutination of the dysentery bacilli.

The readings for the typhoid group were recorded in the form of agglutinin-units (Dreyer) per cubic centimetre serum, and also in titres, those for the dysentery group in titre only, the emulsions containing several strains of each type and averaging about 2,000 millions per cubic centimetre.

Some of the observations cited later pointed to a defect in this technique from the occasional low content or absence of paratyphoid A agglutinins. In further work we should re-examine any serum which yielded positive results for one agglutinin only, by using dilutions, one in ten and one in fifteen, as well as one in twenty-five upwards, in order to confirm the absence of any second agglutinins. We should also carry out absorption experiments on the same serum.

Experimental Observations.

It will be convenient to discuss the several features arising from our observations under the following headings:—

(1) Sera containing both inoculation and infection agglutinins.

(2) Agglutinin units of sera containing inoculation and infection agglutinins determined by absorption methods.

(3) The interactions of inoculation and infection agglutinins.

- (*a*) The raised inoculation titre in the presence of paratyphoid agglutinins A and B.
- (*b*) The increased titres tested by absorption methods.
- (*c*) The end titres in relation to time factors.
- (*d*) The relation of temperatures to end titres.

(4) Sera presenting anomalous changes.

(5) Sera containing typhoid agglutinins only.

I.—Sera in which Inoculation and Paratyphoid Agglutinins were both present.

These sera were obtained chiefly from men during the convalescent stage, but in some instances it was possible to check the serum results by blood cultures and excretal isolations.

In tables A and B are shown the agglutination results obtained in thirty-two cases in which it was possible to make several estimations. In Table A, seventeen cases are included in which the typhoid inoculation titre remained unaltered although the paratyphoid titre and the temperature both varied. Table B contains cases in which the whole of the factors varied. The figures may be summarized as follows:—

Steady Typhoid Titres, 53 per cent.		*Varying Typhoid Titres, 46·9 per cent.*	
In cases up to 6 weeks,	15·6 per cent.	In cases up to 6 weeks,	28·1 per cent.
,, 6-10 ,,	15·6 ,,	,, 6-10 ,,	9·4 ,,
,, 10-20 ,,	21·8 ,,	,, 10-20 ,,	9·4 ,,

The higher agglutination titre of the infective agent in these cases appears from the following tables to show that:—

(1) The infective organism yields the higher agglutinin titre in twenty-eight cases, 87·5 per cent.

(2) The infective organism exhibits the lower agglutinin titre in four cases, 12·5 per cent.

These statements require, however, further qualification, for general evidence seems to point to the fact that in the later weeks of the paratyphoid fever the paratyphoid titre falls rapidly. This higher agglutination must be read therefore in association with the early weeks of the disease. Such a reading shows that:—

TABLE A.

STEADY POST-INOCULATION TYPHOID TITRES IN PARATYPHOID FEVERS.

UNDER 6 WEEKS		WEEKS (AGGLUTININ UNITS AND TEMPERATURES)						
Case number	Weeks since inoculation	(1 Typhoid. Para.	(2) Typhoid. Para.	(3) Typhoid. Para.	(4) Typhoid. Para.	(5) Typhoid. Para.	(6) Typhoid. Para.	—
1	30	—	12 1,380A 100·2°—102·2° F.	12 1,380A 98·8°F.—100·2°F.	10 690A 99° F—100·6° F	—	—	—
2	29	—	29 120A 97·2° F.—98° F.	—	—	—	29 69A	—
3	53	—	—	—	62 — 100·4° F.—102°F.	62 350A 97·4° F.—98° F.	62 46A 97° F.—97·2° F.	—
4	9	—	625 920B 98·4°F.—100·2°F.	625 920B 98° F.—98·4° F.	580 185B 98° F.—99° F.	—	—	—
5	6	—	—	53 92A	—	—	53 46A	—
5 or 6 to 10 weeks		(5) Typhoid. Para.	(6) Typhoid. Para.	(7) Typhoid. Para.	(8) Typhoid. Para.	(9) Typhoid. Para.	(10) Typhoid. Para.	—
6	43	580 912B 99° F.—101·6°F.	—	580 5,000B 97·4° F.—98·2°F.	—	625 1,825B 98° F.	—	—
7	28	—	—	580 920B 98° F.—98·6° F.	580 920B 97° F.—97·6° F.	—	—	—
8	10	—	—	12 46B 98° F.	12 46B 97·6° F.—99·2 F.	—	—	—
9	17	—	58 120A	62 120A	—	—	—	—
10	30	—	580 1,000A	625 925A	—	—	—	—
After 10 weeks		(11) Typhoid. Para.	(12) Typhoid. Para.	(13) Typhoid. Para.	(14) Typhoid. Para.	(15) Typhoid. Para.	(16) Typhoid. Para.	(17) Typhoid. Para.
11	16	—	625 460B 97·8°F—98·2° F.	625 185B 98° F.—98·4° F.	—	—	—	—
12	24	—	—	—	62 92B 97° F.—98·2° F.	62 46B 97° F.—98·2° F.	62 92B 97·4° F.—98·4°F.	—
13	67	—	—	—	—	—	324 1,136B 97·4° F.—98° F.	324 1,136B.
14	38	—	—	—	—	—	162 2,272B 97·4° F.	162 2,272B.
15	63	—	—	162 51A 97·4° F.	162 51A	—	—	—
16	34	—	—	649 255A	649 255A	—	—	—
17	15	—	—	—	—	32 102A 97° F.	32 102A	—

TABLE B.

VARYING POST-INOCULATION TYPHOID TITRES IN PARATYPHOID FEVERS.

UNDER 6 WEEKS		WEEKS (AGGLUTININ UNITS AND TEMPERATURES)															
Case number	Weeks since inoculation	(1) Typhoid.	Para.	(2) Typhoid.	Para.	(3) Typhoid.	Para.	(4) Typhoid.	Para.	(5) Typhoid.	Para.	(6) Typhoid.	Para.	—		—	
1	26	31	345A	62	138A	53	70A	—		—		—		—		—	
		99° F.—99·8° F.		98° F.—98·2° F.		97° F.											
2	19	56	480A	265	960A	265	480A	265	480A	—		196	357A	—		—	
		98° F.—101° F.		98·8°F.—100·2°F.		98·2° F.—98·4 F.		97·8° F.—98° F.									
3	38	29	100B	116	186B	—		125,000	18,888B	125,000	4,629B	—		—		—	
		101·6°F—102·6°F.		101° F.—102° F.				97·8° F.—98° F.		97·4°F.							
4	30	312	694A	125	1,388A	12	347A	10	142A	—		—		—		—	
		101° F.—103° F.		99° F.—101·2° F.		99° F.—99·8° F.		97·6° F.—98·4° F.									
5	32	—		63	92B	580	925B	580	2,000B	—		—		—		(16) 215	560B
				101° F.—102·2 F.		99·6° F.—102·4°F.		97·4°F.—99·4°F.								97° F.	
6	39	—		125	92B	62	46B	12	9B	—		—				—	
				97·2° F.—98·4° F.		97·2° F.—97·8° F.		97·6°F.—98·6°F.									
7	34	—		—		—		192	9B	625	925B	625	1,840B	(7) 580	200B	—	
8	38	—		—		—		125	185B	580	1,000B	580	1,000B	—		—	
9	38	—		—		—		125	46,296B	—		1,250	9,260B	—		—	
								97° F.—98·4° F.				98° F.					
5 to 24 weeks		(5) Typhoid.	Para.	(6) Typhoid.	Para.	(7) Typhoid.	Para.	(8) Typhoid.	Para.	(10) Typhoid.	Para.	(11) Typhoid.	Para.	(12) Typhoid.	Para.	(13) Typhoid	Para.
10	30	29	—	125	—	125	18B	—		—		—		—		—	
		98° F.—98·4° F.		98° F.		98° F.—98·2° F.											
11	51	—		—		32	227B	16	227B	—		—		—		—	
12	54	—		—		—		79	1,136B	396	2,272B	—		—		—	
								101°F.—102·2°F.		98·4°F.—99·4°F.							
13	25	—		—		—		—		162	1,136B	65	2,272B	—		—	
14	38	—		—		—		—		—		—		65	113B	32	45B
15	11	—		—		—		—		324	102B	649	25B	—		—	

First five weeks in 14 *Cases.*

Infective organism produces higher agglutination titre in 13 cases.
,, ,, ,, lower ,, ,, ,, 1 case.

In another series in which it was possible only to examine the blood from the fifth to the twenty-fifth week and then only on one occasion, the findings are as follows :—

Paratyphoid A. Convalescents (5 *to* 25 *weeks*)—108 *Cases.*

Agglutination titre above the inoculation titre,	75	..	69·45 per cent.
,, ,, below ,, ,,	27	..	25 ,,
,, ,, equals ,, ,,	6	..	5·55 ,,

Paratyphoid B. Convalescents (5 *to* 25 *weeks*)—250 *Cases.*

Agglutination titre above the inoculation titre,	130	..	52 per cent.
,, ,, below ,, ,,	75	..	30 ,,
,, ,, equals ,, ,,	45	..	18 ,,

In the acute stages, therefore, these figures support the views of Dreyer, that the higher agglutination belongs to the infective agent; they are less confirmatory with regard to the steady value of the typhoid inoculation titre during the acute stage and in the presence of infective agglutinins.

If Dreyer's statement is applied to the later periods of disease—and it must be remembered that it was not suggested that it would be applicable—then the reverse conditions obtain. The steady typhoid titre occurs in 76·5 per cent and is of more value than the high agglutination one, since the infective agglutinin tends to fall in stages. This confirms the 1911 work of Grattan and Wood [15].

When, however, only single examinations are possible, instances occur in which the inoculation and the disease titres are equal, or the infective agglutinin is appreciably lower than the inoculation one. In such cases, when blood culture and blood counts are of little assistance and the excreta yield negative results, diagnosis is difficult in the absence of any history of definite bacteriological diagnosis in the acute stage, and calls for further information. The points which give rise to doubt are those concerned with the presence or absence of co-agglutinins and their titres. If group agglutinins do play a part in these stages, a knowledge of the extent of their influence is necessary, in order to establish a level of agglutinin units below which any agglutination should be disregarded. With this end in view, the sera of a number of cases, selected from varying weeks of disease, were examined for their agglutinin contents and the results compared with those obtained by absorption processes carried out with the usual controls and precautions.

TABLE C.

Absorption Values.

Post-inoculation Typhoid Agglutination Titres during Paratyphoid Fevers and Convalescence.

Weeks of disease	Case number	Weeks since inoculation	Agglutination Units		Absorption Units		Remarks
			Typhoid	Paratyphoids	Typhoid	Paratyphoids	
1st week	1	78	31	345A	31	345A	Equal.
	2	21	56	480A	56	480A	,,
	3	34	312	694A	24	347A	Both vary.
2nd ,,	4	30	12	1,380A	12	1,380A	Equal.
	5	39	58	186B	58	186B	,,
3rd ,,	6	33	580	925B	580	925B	,,
6th ,,	7	36	580	1,000B	116	200B	Both vary.
	8	18	198	357A	198	357A	Equal.
	9	33	198	357A	198	357A	,,
	10	44	106	1,420A	106	1,420A	,,
	11	43	793	714B	396	714B	T. varies.
	12	19	79	714A	198	357A	Both vary.
	13	15	396	227B	198	113B	,,
7th ,,	14	17	62	120A	31	60A	,,
	15	30	625	925B	321	462B	,,
	16	28	580	925B	580	925B	Equal.
	17	10	12	46B	12	46B	,,
	18	51	16	227B	16	227B	,,
	19	43	460	694B	90	694B	T. varies.
	20	67	4	227B	4	227B	Equal.
8th ,,	21	54	79	1,136B	79	1,136B	,,
	22	38	62	18B	62	18B	,,
	23	35	53	142A	53	71A	A. varies.
	24	67	223	35A	223	35A	Equal.
	25	62	396	71A	79	71A	T. varies.
	26	67	396	1,136B	396	1,136B	Equal.
	27	59	198	568B	198	568B	,,
	28	67	792	568B	198	568B	T. varies.
	29	19	396	714A	198	143A	Both vary.
9th ,,	30	67	39	71A	39	71A	Equal.
	31	47	39	36A	39	36A	,,
	32	51	39	35A	39	35A	,,
	33	60	125	462B	125	462B	,,
	34	11	198	2,272B	79	1,136B	Both vary.
11th ,,	35	25	65	2,272B	65	2,272B	Equal.
	36	11	649	25B	649	25B	,,
	37	15	39	227B	39	227B	,,
12th ,,	38	39	62	9B	62	9B	,,
13th ,,	39	16	625	185B	625	185B	,,
	40	38	32	45B	32	45B	,,
14th ,,	41	63	162	51A	162	51A	,,
	42	34	649	255A	649	255A	,,
16th ,,	43	15	32	102A	32	102A	,,
17th ,,	44	67	324	1,136A	324	1,136A	,,
19th ,,	45	38	162	2,272A	162	2,272A	,,

II.—Agglutination Units determined by Absorption Methods.

With the object of investigating the dependence of the agglutination titres upon group reactions or co-agglutinins, forty-five cases were selected from varying stages of the diseases. The titres for the typhoid and paratyphoid agglutinins having been determined from separate portions of the same serum, the individual agglutinins were absorbed and the agglutination values of each absorbed serum ascertained for typhoid and paratyphoid bacilli. The results are set forth in Table C, classified according to the week of disease. They might also have been recorded so as to point to the fact that—

In 21 paratyphoid A cases	16 showed a *higher* agglutination titre than the inoculation titre. 5 showed a *lower* agglutination titre than the inoculation titre.
In 30 paratyphoid B cases	24 showed a *higher* agglutination titre than the inoculation titre. 6 showed a *lower* agglutination titre than the inoculation titre.

A consideration of these figures shows that in Cases 11, 12, 13, 14, 15, 23, 29 and 34 (Table C) there are variations which to those accustomed to read agglutinin reactions will be understood as mean variations; they all represent the next dilution, above or below. In the cases 3, 7, 19, 25 and 28, however, there are definite differences between the agglutinin and the absorption titres. Hence the results of the observations permit the following summary:—

Agglutination and absorption titres agree in 32 cases ..	71·1 per cent.
,, ,, ,, show mean variations in 8 cases	17·7 ,,
	88·8 per cent.
,, ,, ,, differ in 5 cases ..	11·2 ,,

The data yielded by these absorptions may be taken to suggest that in the greater number of cases, the conditions induced in the sera by preventive inoculation and infection are specific for the bacteria concerned, and that when careful precautions are taken with the agglutinable material, co- or group-agglutinins do not play a part.

With regard to the cases which show definite differences, it is the inoculation titre which is chiefly affected, the change being apparent in the late as well as in the early weeks of the disease.

Perhaps No. 7 should be excluded from this category, as it appears to be the result of some technical failure, for if both the absorption factors were multiplied by 5, the agglutinin and absorption figures would agree.

	No.	Typhoid	Para A		No.	Typhoid	Para B
		Units	Units			Units	Units
1st week ..	3	312	694	6th week ..	7	580	1,000
Absorption		24	347	Absorption		116	200
8th week ..	25	396	71	7th week ..	19	460	694
		79	71			90	694
				8th week ..	28	792	568
						198	568

In the other instances, the differences occur in the inoculation agglutinin titre in each case, the infection titre remaining unaltered. The same stability occurs in the whole of the infective agglutinin figures, viz., in those in which the infection titre is equal to or below the inoculation titre, as well as in those above it.

Many of the infection titres shown in Table C are as low as 35, 25 or even 9 units; but the absorption results make it clear that these are definite infective agglutination results and not due to any group agglutinin influences.

It seems probable, therefore, that in cases of inoculated men a positive agglutination 1 in 25 dilution is definitely indicative of paratyphoidal infections.

The case for the inoculation agglutinin is in a different category. We have met with several cases in which the inoculation agglutinin followed closely the upward curve of the infective agglutinin without interfering with the substances which bring about the infective agglutination, while in others it was swung upwards to a titre far higher than that of the infective titre. What the conditions are which determine these variations is far from clear and it may be worth while to pursue this interaction of agglutinin phenomena a little further.

III.—Interaction of Inoculation and Infection Agglutinins.

(a) *The Raised Inoculation Titre in the Presence of Paratyphoid A and Paratyphoid B Agglutinins.*

The concluding words of the last section suggested that there are possibilities of interaction between the inoculation and infection agglutinins which may throw some light upon certain problems likely to arise in connexion with the serology of men who have been inoculated with mixed typhoid, paratyphoid and cholera vaccines.

For a survey of the information gained from a study of the

inoculation agglutinins, the end titres obtained in 268 cases which were sent in as free from clinical symptoms of typhoidal conditions and which proved on laboratory examination to yield negative findings for typhoïd, paratyphoid and dysentery bacilli, and also for pathogenic protozoa, are stated in Table D. The table is arranged so as to afford a rough idea of the relation between the time elapsed since inoculation and the persistence of agglutinin capacity. The weekly variation in the number of units is very similar: in fact,

TABLE D.—TYPHOID INOCULATION AGGLUTINATION UNITS PER CUBIC CENTIMETRE OF SERUM IN 268 CASES NOT CLINICALLY ENTERIC, WHERE B. TYPHOSUS IS THE ONLY ORGANISM AGGLUTINATED.

Weeks since inoculation	Number of cases	Units. Under 3 Titre (rough average)	3—15 1/25—1/50	15—35 1/125	35—65 1/250	65—150 1/500	150—350 1/1250	350—650 1/2500	650—1,250 1/5000	Over 1,250 Over 1/5000
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
1—10 weeks	22	..	18·2	27·3	22·7	27·3	4·5	..	..	..
11—20 ,,	67	1·5	20·9	22·4	26·8	16·4	7·5	1·5	3·0	..
21—30 ,,	50	2·0	14·0	28·0	28·0	22·0	2·0	2·0	2·0	..
31—40 ,,	31	..	25·8	41·9	12·9	19·4	..	..	..	..
41—50 ,,	26	7·7	19·2	27·0	30·7	15·4	..	..	..	..
51—60 ,,	43	..	16·3	23·3	27·9	30·2	2·3	..	..	..
61—70 ,,	24	8·3	8·3	29·2	16·7	25·0	4·2	8·3	..	..
71—80 ,,	5	..	..	40·0	20·0	..	20·0	20·0	..	..
Total percentages for each group of units		2·4	15·3	29·9	23·2	19·5	5·1	4·0	0·6	..

when curves are made for each week, they nearly all coincide. An exact comparison with these figures has not been found, for although several papers have appeared stating the agglutinin results following preventive typhoid inoculation, few workers have carried out the estimations to the end titre. In a communication of Dreyer and Inman [12], however, certain figures are given from post-inoculation agglutinations in healthy individuals, which permit of the following comparison :—

Agglutinin units	DREYER AND INMAN [4] 56 cases (1—30 weeks) after inoculation	OUR OBSERVATIONS. 268 cases (1—30 weeks after inoculation)	(1—80 weeks after inoculation)
	Per cent	Per cent	Per cent
Under 3	—	1·2	2·4
3 to 15	—	17·7	15·3
15 to 35	5·36	25·9	29·9
35 to 65	19·65	25·9	23·2
65 to 150	35·71	21·9	19·5
150 to 350	25·00	4·6	5·1
350 to 650	7·18	1·2	4·0
650 to 1,250	1·79	1·6	0·6
Over 1,250	5·31	—	—

These two sets of figures convince us that our 228 examples of inoculation agglutinins do not show any sign of the inclusion of cases of enteric convalescents and permit the contrast of these percentages with a similar table of the estimations of inoculation agglutinins in cases of definite paratyphoid fever.

TABLE E.—TYPHOID INOCULATION AGGLUTINATION UNITS PER CUBIC CENTIMETRE OF SERUM IN 335 CASES IN THE PRESENCE OF PARATYPHOID AGGLUTININS.

Weeks since inoculation	Number of cases	Units. Under 3. Titre (rough average)	3—15 1/25—1/50	15—35 1/125	35—65 1/250	65—150 1/500	150—350 1/1250	350—650 1/2500	650—1,250 1/5000	Over 1,250 Over 1/5000
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
1—10 weeks	11	..	9·1	27·3	9·1	27·3	18·2	9·1	..	..
11—20 ,,	72	..	11·1	19·4	23·6	19·4	18·1	8·3	..	..
21—30 ,,	55	..	5·4	12·7	21·8	18·2	25·4	12·7	1·8	1·8
31—40 ,,	54	..	16·7	14·8	20·4	22·2	7·4	14·8	3·7	..
41—50 ,,	38	..	10·58	21·05	13·2	26·3	10·5	10·5	5·3	2·6
51—60 ,,	61	..	29·5	19·7	19·7	19·7	4·9	4·9	1·6	..
61—70 ,,	36	..	11·1	16·6	19·4	22·2	16·6	8·3	5·5	..
71—80 ,,	8	..	..	..	75·0	12·5	..	12·5	..	..
Total percentage in each group of units			11·7	16·5	25·3	21·0	12·6	10·13	2·23	0·54

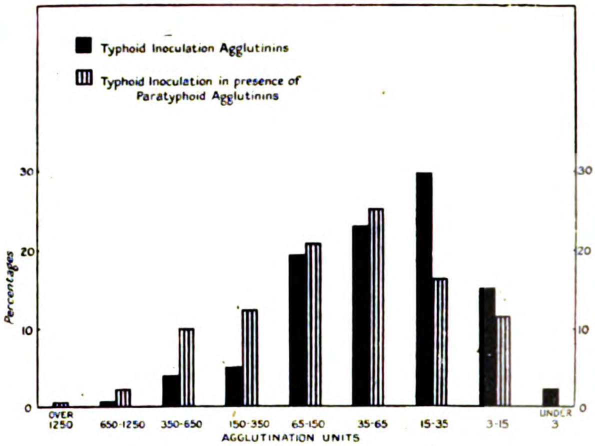
WITH TWO SETS OF INOCULATIONS—18 CASES.

Weeks since last inoculation	Number of cases	Under 3	3—15	15—35	35—65	65—150	150—350	350—650	650—1,250	Over 1,250
1—10 weeks	7	..	28·57	14·29	14·29	14·29	..	28·57	..	..
11—20 ,,	1	..	..	100·0	..	..	..	..	..	..
21—30 ,,	3	..	..	..	..	..	33·3	33·3	..	33·3
31—40 ,,	2	..	..	..	50·0	50·0	..	..	..	..
41—50 ,,	4	..	..	50·0	25·0	25·0	..	..	..	..
51—60 ,,	1	..	..	..	..	100·0	..	..	..	..

If the totals shown in Table D are compared with those in Table E, that is to say, estimations of the inoculation agglutinins of the healthy are put side by side with estimations of the inoculation agglutinins obtained from paratyphoidal sera, a striking rise in the latter will be noted. This is, perhaps, more clearly evident in Diagram I, which shows the numbers of men in each category who possess the same quantities of preventive typhoid agglutinins. Reading the diagram from left to right, there are a larger number of high inoculation units among the men who exhibited the effects of paratyphoid infection than among those who were healthy. In other words, the mass figures point to a rise in extent of inoculation agglutinins when an infection is manifested. Whether this increased titre is a general one, or only relates to the type of cases

already mentioned as showing variable inoculation agglutinins, is a matter for further discussion.

DIAGRAM I.



The next step, perhaps, is to inquire if this effect is due to the association of one or both of the paratyphoid bacilli and if there is any difference in the intensity of the action. To be able to answer this question, the 335 cases of paratyphoid fever must be separated into the A and B varieties, and tables similar to E prepared. This partition reveals 136 cases of paratyphoid A and 199 cases of paratyphoid B. The typhoid inoculation agglutinins present in these cases are depicted in Diagram II in a manner which allows of their comparison with the agglutinins of healthy inoculated men. Both the curves and the uprights bring out the increase of the inoculation agglutinins in the presence of the paratyphoid antibodies, as well as the fact that the titre is higher when paratyphoid B is the infective organism than it is when paratyphoid A is causal. These findings are what the R.A.M.C. workers and Dreyer, Gibson, Walker and Martin have led us to expect [12], [14].

Such broad indications, however, call for a closer study of individual cases before their acceptance is permissible. Accordingly, some further work has been done upon the materials from some acute and sub-acute cases which came to hand in the course of routine examinations. This closer inquiry comprised the carrying out of regular series of agglutination estimations and controlling them by a determination of the absorption values of the same specimen of blood. By these means it was thought that the

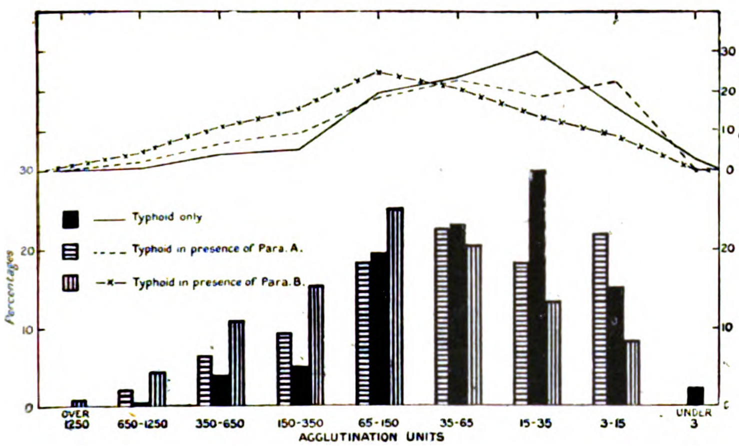
question of co- and group-agglutinin action on the dead emulsions employed might be within reach of solution and the effect of the presence of the infective agglutinins be expressed in precise figures.

(*b*) *The increased Titres tested by Absorption Methods.*

The results collected in this way are incorporated in Table F. They will be read easily by those who are accustomed to this type of record, but for explanatory purposes it may be better to take three typical cases and demonstrate them in the form of Charts X, Y and Z.

DIAGRAM II.

TYPHOID INOCULATION AGGLUTININS IN PRESENCE OF PARATYPHOID AGGLUTININS (A AND B).



In X, there is an instance of a case of paratyphoid A fever, in which the infective titre reaches its height on the ninth day, and then gradually falls: the inoculation titre rises at first and then falls almost at the same time as the infection titre, but does not reach its original position by the sixth week. The absorption values are the same as the agglutinin values and suggest that the factor responsible for the rise of the inoculation titre was one which remained in the serum after the infective-agglutinin had been removed.

In Y, a case of paratyphoid B, the absorption values correspond closely with the agglutinin titres, but here the inoculation titre is swung up seven times as high as the infection titre during the third and fourth weeks, and remains at the same level when the

TABLE F.

THE ABSORPTION VALUES FOR INOCULATION AND INFECTIVE AGGLUTININS IN PARATYPHOID FEVERS.

Number of case	Weeks since inoculation		Weeks of Disease											
			1st week		2nd week		3rd week		4th week		5th week		6th week	
			Typhoid.	Para.	Typhoid.	Para.	Typhoid.	Para.	Typhoid.	Para.	Typhoid.	Para.	Typhoid.	Para.
1	19	Agglutinins ..	56	A480	265	A960	265	A480	265	A480	—	—	198	A357
—	—	Absorption values	56	480	265	960	265	480	265	480	—	—	198	357
2	38	Agglutinins ..	29	B100	116	B186	—	—	125,000	B18,888	125,000	B4,629	—	—
—	—	Absorption values	—	—	58	186	—	—	125,000	18,888	125,000	4,629	—	—
3	30	Agglutinins ..	312	A694	125	A1,388	12	A347	10	A142	—	—	—	—
—	—	Absorption values	24	347	60	347	12	347	—	—	—	—	—	—
4	30	Agglutinins ..	—	—	12	A1,388	12	A1,388	10	A694	—	—	—	—
—	—	Absorption values	—	—	12	1,388	—	—	—	—	—	—	—	—
5	32	Agglutinins ..	—	—	63	B92	580	B925	580	B2,000	—	—	—	—
—	—	Absorption values	—	—	—	—	580	925	—	—	—	—	—	—

TABLE F.—*continued.*

Number of case	Weeks since inoculation	—	Weeks of disease: 7th week Typhoid.	7th week Para.	8th week Typhoid.	8th week Para.	10th week Typhoid.	10th week Para.	11th week Typhoid.	11th week Para.	—	—	—	—
6	28	Agglutinins ..	580	B920	580	B920	—	—	—	—	—	—	—	—
—	—	Absorption values	580	920	—	—	—	—	—	—	—	—	—	—
7	10	Agglutinins ..	12	B46	12	B46	—	—	—	—	—	—	—	—
—	—	Absorption values	12	46	—	—	—	—	—	—	—	—	—	—
8	54	Agglutinins ..	—	—	79	B1,136	396	B2,272	—	—	—	—	—	—
—	—	Absorption values	—	—	79	1,136	396	2,272	—	—	—	—	—	—
9	51	Agglutinins ..	32	B227	16	B227	—	—	—	—	—	—	—	—
—	—	Absorption values	—	—	16	227	—	—	—	—	—	—	—	—
10	25	Agglutinins ..	—	—	—	—	162	B1,136	65	B2,272	—	—	—	—
—	—	Absorption values	—	—	—	—	—	—	65	2,272	—	—	—	—
11	11	Agglutinins ..	—	—	—	—	324	A102	649	A25	—	—	—	—
—	—	Absorption values	—	—	—	—	—	—	649	25	—	—	—	—

Number of case	Weeks since inoculation	—	12th week Typhoid.	12th week Para.	13th week Typhoid.	13th week Para.	14th week Typhoid.	14th week Para.	15th week Typhoid.	15th week Para.	16th week Typhoid.	16th week Para.	17th week Typhoid.	17th week Para.
12	16	Agglutinins ..	625	B460	625	B185	—	—	—	—	—	—	—	—
—	—	Absorption values	—	—	625	185	—	—	—	—	—	—	—	—
13	38	Agglutinins ..	65	B113	32	B45	—	—	—	—	—	—	—	—
—	—	Absorption values	—	—	32	45	—	—	—	—	—	—	—	—
14	63	Agglutinins ..	—	—	162	A51	162	A51	—	—	—	—	—	—
—	—	Absorption values	—	—	—	—	162	51	—	—	—	—	—	—
15	34	Agglutinins ..	—	—	649	A255	649	A255	—	—	—	—	—	—
—	—	Absorption values	—	—	—	—	649	255	—	—	—	—	—	—
16	15	Agglutinins ..	—	—	—	—	32	A102	32	A102	—	—	—	—
—	—	Absorption values	—	—	—	—	—	—	32	102	—	—	—	—
17	67	Agglutinins ..	—	—	—	—	—	—	—	—	324	B1,136	324	B1,136
—	—	Absorption values	—	—	—	—	—	—	—	—	—	—	324	1,136
18	38	Agglutinins ..	—	—	—	—	—	—	—	—	162	B2,272	162	B2,272
—	—	Absorption values	—	—	—	—	—	—	—	—	—	—	162	2,272

CHART X.

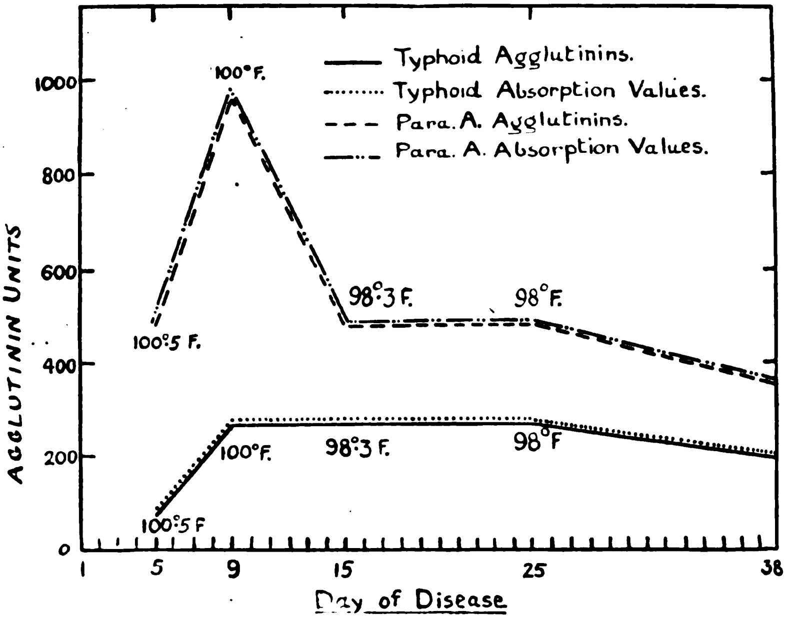
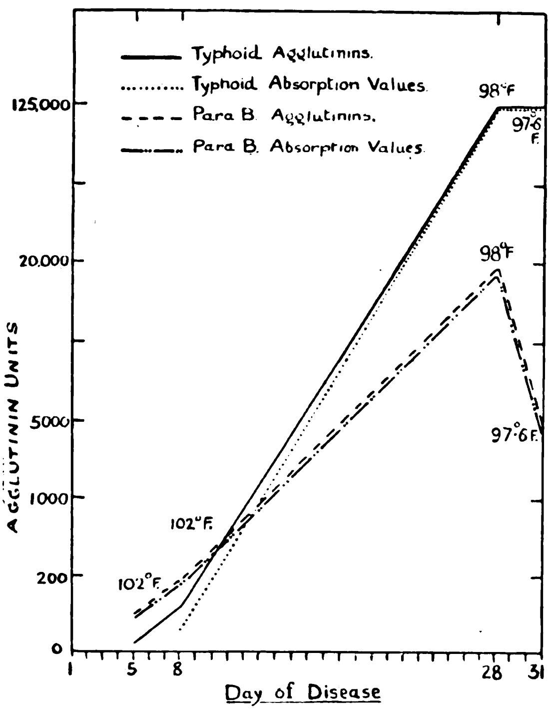


CHART Y.



man recovers and ceases to provide opportunities for further observations.

In Chart Z, a case of paratyphoid A, the inoculation agglutinins steadily fall, but it is only during the third week that the absorption values correspond to the agglutinin titre. The infective agglutinins yield the usual upward and downward curve, but here again it is the third week before the absorption values and the agglutinin titres correspond. These figures are somewhat similar to those recorded in Table II. They do not suggest the action of co-agglutinins, since these are supposed to demand more concentration of the serum than the findings represent: they are due more probably to some defects in our present-day technique of absorption processes. Still, they represent a condition which may be further investigated as occasion arises.

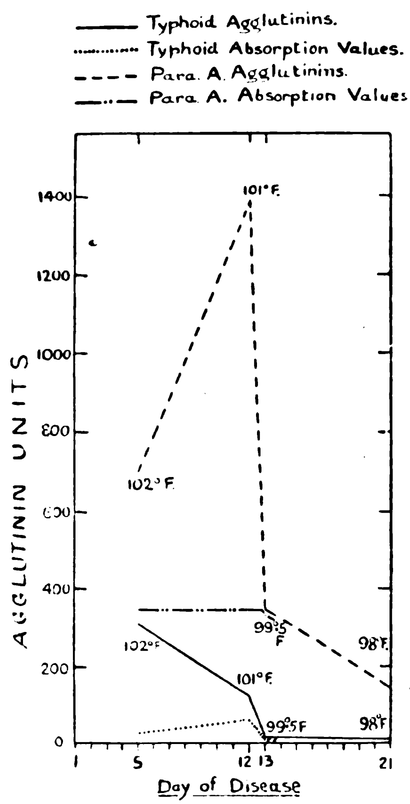
In any case, these absorption experiments point to the possibility that inoculation agglutinins do not exert any co-agglutinating action on infective agglutinins, and that infective agglutinins do not cause the co-agglutination of inoculation agglutinins, in spite of the fact that they are associated with some change which increases the specific agglutinating power of the serum for the inoculation agglutinins.

Perhaps the view should be put forward that in these reactions we are not concerned with co-agglutinative action manifested by infective sera for living or dead organisms of a kindred type, but with the conditions induced in the blood serum by the injection of killed typhoid bacilli as compared, or contrasted as the case may be, with those following the irritant effect of tissue lysed bacilli. It is not therefore a matter of co-agglutination by one or both sets of antibodies, but of possible interaction of two variant substances. Before the much contested question of co-agglutination is set at rest, it may be found necessary to determine whether the tissue enzymes are able to induce the same line of protein cleavage from bacilli killed by heat, formalin, or autolytic processes, as they are from bacteria subjected to bacteriolytic action alone. When this has been decided, it will be possible to consider how far the cleavage products resulting from the action of tissue fluids upon artificially altered protein are likely to lead to the production of inhibitory factors nearly, or precisely, similar to those following the absorption of naturally changed proteins. The outlook would take us too far afield were we to speculate upon the probable amino-acid and peptide combinations of these antigenic and antibody formations, but it may remind us not too readily to assume

that biological reaction is so automatic that it is compelled to utilize, always and solely, this or that specific physical, or chemical, process.

One reading of the results of these absorption experiments might suppose that some new condition of solution or isomerism is associated with the presence of antibodies in the blood serum.

CHART Z.



If this did prove to be a correct conjecture, it would furnish a tangible explanation of the facts we have observed. In other words, the raising of the inoculation titre in the presence of an infective agglutinin would be ascribed to a correlated physical change in the serum, and not to a co-agglutinin in the sense in which the latter term is now understood.

There is no doubt that some of these cases furnish puzzles

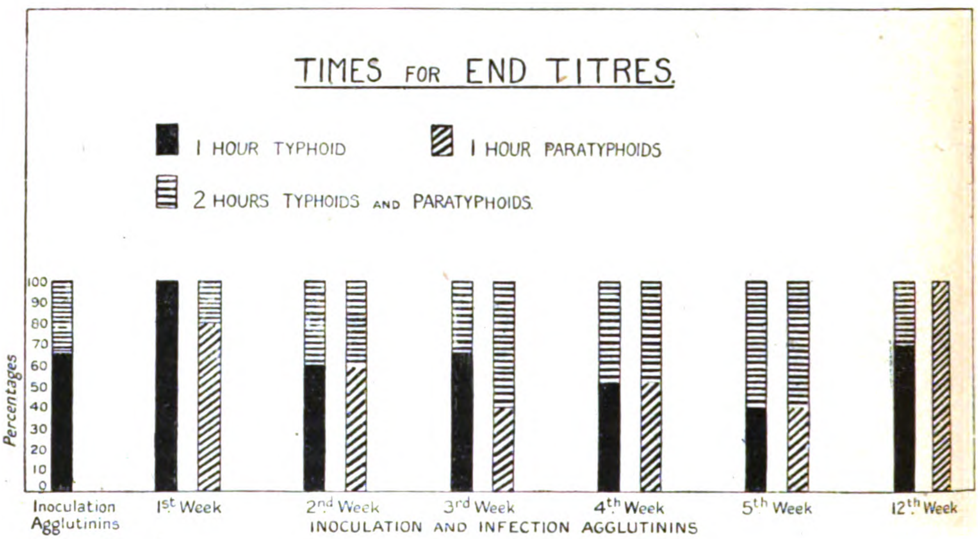
which make dogmatic statements upon agglutinin but vainglories. Considerable aid is afforded to the clinician by the present methods, but it may not be forgotten that fallacies and difficulties will continue to arise, until the bio- and physical-chemists have settled outstanding problems connected with the conditions which inhibit or promote the numerous possibilities of peptide formations during the lysis of inoculation or infective bacilli, and in connexion with the production of the opposing antibodies, or whatever substances are covered by this term nowadays.

How long does the Rise in the Inoculation Agglutinins continue?—An aspect of the problem which is of considerable interest is related to the temporary or permanent effect of the presence of the infective agglutinin upon the inoculation titre. The opportunities for making observations upon the point have been limited. In a few instances, the inoculation agglutinin has been high when the patient passed out of hand; in the greater number it had fallen to the level of the first examination; in several cases it was lower than it was on the fifth day of attack. Before any comment can be made on findings such as these, further figures must be accumulated.

Does the Paratyphoid Attack affect the Immunity against Typhoid Fever in Inoculated Men?—This question follows naturally upon the statements made under the previous heading. If it is agreed that the inoculation antibody amount, as measured by methods at present available, is raised by the serum conditions present during resistance to infection, then it is fair to ask if this carries with it any increased resistance to the disease, or diseases, against which the man has been inoculated. This is a matter for later observations upon paratyphoid convalescents. If these men return to hospital at any time, it will be of value to examine them serologically. In each case examined in this laboratory the full details of the observations are entered on cards and will be available for reference. When these cards are completed and sent to a central body, it should not be impossible for the information accumulated in other hospitals upon the same case to be put together and this question made capable of solution by statistical methods. In the meantime, it may be remembered that antibodies are not confined to the blood alone. We have found them in exudates and transudates and it is probable that the greater part of the tissue fluids contains them. We should expect therefore that the widespread distribution of any physical or chemical change which raises the antibody reaction against a bacillus should confer an increased immunity so long as the altered condition persists.

Several features of the reactions we have recorded tempt us to a chemical concept of the process, although we recognize the probability of dominant physical influences. The current terms of "inoculation and infective agglutinins" have been used therefore simply for purposes of convenience. From the physical standpoint, however, it occurred to us that it might be worth while to determine whether the reaction time or the presence of pyrexia would furnish any indications of the nature of the agglutination or provide any information useful for diagnostic purposes. To this end, we examined a number of agglutinations at stated intervals.

DIAGRAM III.



(c) End Titres. Does the Time Factor distinguish between Inoculation and Infective Agglutinins?

In all our estimations the end titre has been determined. For a considerable period, at the commencement of the work, the tests were examined at the end of the first hour, and at the end of the second hour. In some cases they were examined half-hourly. The results of the series are shown in Diagram III. It was thought that these might indicate that the infective agglutinins reacted more rapidly than those due to inoculations, since we had found that of the inoculation agglutinins 70 per cent were completed at the end of one hour, while 30 per cent

required two hours for the end titre. This was not the case. During the first week of disease, the end titre of the inoculation agglutinins was reached within the hour in 100 per cent of cases, while of the infective cases 70 per cent only were complete in one hour. The estimations of the following weeks show that the time factor of the two types gradually approximates.

The number of cases examined in this way did not exceed 100 and we are reluctant to draw any conclusion until a mass of similar figures has been accumulated. In the meantime, we have ceased to expect any help in diagnosis from the rapidity of agglutination.

However, the appearances of the chart seem to offer a further confirmation of the alterations in the inoculation agglutinations occasioned by the additional tension or electrical potential change in the blood serum which is responsible for the specific infective agglutinins.

(*d*) *The Relation of Temperature to End Titres.*

The highest titres of the infective agglutinins occur within about ten to twenty days of the onset of the attack, and as a rule reach a climax during the fall of temperature (see Tables A and B). When the inoculation agglutinin does not remain at a steady level, it also tends to reach its height during the same period. The fall of the inoculation agglutination to its pre-pyrexial level is generally more sudden than that of the infective type. The mass figures already stated tend to show that in those instances in which the inoculation agglutinin is subjected to serum changes affecting its titre, the first and the final titres are generally approximate and the intermediate variations are greater in the presence of paratyphoid B agglutinins than in those of paratyphoid A. It has not been our experience to note the disappearance of the inoculation agglutinin during the pyrexial stages (see Tables A and B).

When we turn to the consideration of inoculation agglutinins in the presence of changes due to infection by other bacteria, we have not found that pyrexia is associated with inhibition or diminution of the agglutinin titre. The following estimations support this statement (Table G).

IV.—Anomalous Cases.

The agglutinins present in cases of paratyphoid A fever appear to be developed to a different extent from those of paratyphoid B and to exert a less effect upon the inoculation agglutinins. In one

case, although definite paratyphoid A bacilli were isolated from the blood, it was not possible to identify any paratyphoid A agglutinins. In a second instance, paratyphoid A had been obtained from the blood at another hospital, but agglutinins were not demonstrable in the serum. The inoculation agglutinins showed variations in each case. This caused us to re-examine the organisms recovered from the blood in our case. It still gave definite paratyphoid A reactions and its identity was confirmed.

TABLE G.

No. of case	Disease	Temperature	Inoculation titre	Temperature	Inoculation titre	Weeks since inoculation
1	Pneumonia ..	105° F.	1/250	..	..	65
2	Shrapnel wound ..	103° ,,	1/5000	98° F.	1/1250	26
3	G. W. leg	103° ,,	1/500	98·4° F.	1/500	78
4	Pyrexia	103° ,,	1/2500	..	..	20 ?
5	Continued fever ..	102° ,,	1/125	..	..	130
6	Paratyphoid, 3 days	102° ,,	1/250	..	..	36
7	Paratyphoid, 5 days	102° ,,	1/125	..	..	40
8	Wound—jaw ..	102° ,,	1/2500	..	..	18
9	Wound—hand ..	102° ,,	1/5000	98° F.	1/5000	16
10	Hernia, 5 days ..	102° ,,	1/500	98° F.	1/500	68
11	Tuberculosis ..	101·8° ,,	1/125	..	..	(1907)
12	Colostomy	100·6° ,,	1/125	98·2° F.	1/250	64
13	Amputation—leg ..	100·6° ,,	1/1250	98·2° F.	1/1250	20
14	Appendicitis ..	100·4° ,,	1/500	..	..	20
15	Rheumatism ..	100° ,,	1/500	..	..	—
16	Wound—chest ..	99·9° ,,	1/1250	98·6° F.	1/1250	64
17	Empyæma	99·4° ,,	1/500	98° F.	1/500	68
18	G. W. legs	101·4° ,,	1/5000	98·2° F.	1/5000	60
19	Pericarditis ..	100° ,,	1/1250	98·4° F.	1/1250	68
20	Cellulitis—leg ..	101° ,,	1/1250	..	..	..
21	G. W. leg	104° ,,	1/2500	98·4° F.	1/2500	..

Was our technique at fault in these instances? Dreyer states that he failed to obtain evidence of agglutination in a small number of paratyphoid A cases until he used dilutions as low as one in ten (10). To this extent our method was certainly defective. Since then we have applied this dilution when expected agglutinins did not appear, but so far we have not met with similar cases.

V.—Sera containing Typhoid Agglutinins only.

In the case of individuals who have been inoculated against the intestinal group of infectious diseases, it is of importance to distinguish between the agglutinins following the preventive measures and those produced in response to an infection. In the

absence of information of bacteriological findings during the early days, we had to consider some 169 cases (29·1 per cent of the total) which had exhibited enteric symptoms in early stages, but which failed to afford evidence of the presence of agglutinins other than those for *B. typhosus*.

For about fifty per cent of these, the statement of Dreyer, that the inoculation agglutinin remains at a steady titre upon two or three successive estimations, proved correct, and was of assistance in providing a diagnosis.

For the remainder, we endeavoured without avail to obtain guidance from the time factor in relation to the rapidity of the agglutinations; also from observations upon the association of pyrexia and agglutinin content as suggested by Tidy, but without gaining corroborative evidence. It was a matter of regret that we were not able at the time to apply the findings of Dawson, working under Delépine, that the infective agglutinins cause a serological change which brings about the clumping of a particular strain of Gaertner's bacilli, for he supports his claim with the results of blood cultures and fæcal isolations in several cases.

We were left, therefore, with a number of cases, which, with the exception of two, exhibited agglutinin contents which did not exceed the average percentage amounts found in healthy men, and which did not suggest that they represented the falling titres observed after disease or multiple preventive inoculations. Further, we had found that 10 per cent of the paratyphoid cases showed a heavy infection with *Entamœba histolytica*, 22 per cent with *Entamœba coli* and, in the last series, 9 per cent with *Lamblia intestinalis*—conditions which might have occasioned symptoms suggestive of typhoid fever in the early days of the first rush of cases at the Mediterranean Front. While in not a single one of these cases had we found any typhoid, paratyphoid or dysentery bacilli in the excreta.

For such reasons, therefore, we considered that from the agglutinin standpoint, these cases should be returned as inoculation agglutinins only and not as enteric convalescents. It would be convincing from the statistical side if these and similar instances were placed in a class to themselves, and not included among those identified beyond doubt by the isolation of infective typhoid bacilli from the blood, stools or urine.

In the light of our experience with paratyphoid A cases, we must point out, however, that some of these 169 men may have been anomalous examples of paratyphoid A fever, as our agglutinin

technique did not provide for a lower dilution than two units per cubic centimetre serum. It would have been more satisfactory if absorption experiments had been carried out in these cases and the typhoid agglutinin-free serum tested for paratyphoid A agglutinin in low dilutions. Since we realized this, we have applied the proposal to a few cases, but as yet a positive agglutination under two units per cubic centimetre serum has not been obtained.

SUMMARY.

(1) *Inoculation Agglutinins.*—The determination of the end titre in 268 men yielded under two per cent in which the agglutination was negative or less than two units per cubic centimetre of serum during the first ten weeks following inoculation, and under ten per cent up to seventy weeks. In a series of 335 cases of paratyphoid fever, only 0·3 per cent were negative or under two agglutinin units per cubic centimetre, and 1·6 per cent from thirty to eighty weeks; other and later results confirm the findings. These figures indicate a higher and more persistent agglutinin content than is generally appreciated, and form a striking tribute to the care taken in the preparation of the emulsions and in the carrying out of the routine methods of injection.

(2) In the presence of infective paratyphoid agglutinins, the inoculation titre remains steady in fifty-three per cent of cases, but in the remainder it varies and often rises considerably. This rise is higher with paratyphoid B than with paratyphoid A infections.

(3) The absorption values for the inoculation and infective agglutinins have been determined in the mass and in individual cases. The results show that the rise is not due to any group, or co-agglutination effects, but is specific for each type of agglutinin.

(4) *Infective Agglutinins.*—From the findings of absorption determinations it is evident that in the presence of inoculation agglutinins, a positive agglutination with the supposed infective organism is definitely indicative even as low as 1 in 25 dilution. This confirms the statements of Grattan and Wood, Harvey and Dreyer and co-workers [15], [16], [12].

(5) The infective agglutinin yields a higher titre than the inoculation titre in 92·5 per cent during the first five weeks of the disease and in 87·5 per cent up to the twentieth week This amplifies the work of Grattan and Wood, and supports some of their findings [15].

(6) The inoculation and infective agglutinins cannot be

differentiated by determinations of the times required for the completion of the end titres.

(7) Pyrexia does not appear to exert any inhibitory influence upon the inoculation agglutinins.

It is with pleasure we express our thanks to Lieutenant-Colonel J. Paul Bush, C.M.G., Lieutenant-Colonel J. Michell Clarke, and the whole Staff of the Second Southern General Hospital for their provision of material in the form requested; to Captain Carey Coombs for his assistance in the early part of the work; to Mr. R. E. Savage, A.R.C.S., D.I.C., for his aid in the preparation of curves and diagrams, and to the Medical Research Committee for the continuous supply of standardized emulsions and sera.

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A SHORT NOTE ON WEIL'S DISEASE (*SPIROCHÆTOSIS ICTEROHÆMORRHAGICA*) AS IT HAS OCCURRED IN THE ARMY IN FLANDERS.

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AND
Captain JOHN A. RYLE.
Royal Army Medical Corps.

Interest in the subject of infectious jaundice has lately been re-opened by a monograph from Doctors Inada, Ido, Hoki, Kaneko and Ito which appeared in the *Journal of Experimental Medicine* of March 1, 1916. Weil first described the disease which bears his name in 1886. It was characterized by jaundice, pyrexia, hæmorrhages and the fact that it was apparently infectious, as the cases occurred either in widespread epidemics, or localized groups of cases, or sometimes all the members of a single family would be affected at the same time. In the British Isles the epidemic form is rare but the family type of infectious jaundice is well-known. Widespread epidemics have been seen in the United States and outbreaks have been reported in India, Africa and the Near East. To quote the Japanese workers, "In the western part of Japan there prevails an epidemic and endemic disease characterized by conjunctival congestion, muscular pains, fever, jaundice, hæmorrhagic diathesis and albuminuria, which is known as Weil's disease or febrile jaundice. At the end of last year (1914) the same disease was observed in Chibia in the eastern part of Japan, near Tokyo, where the patients numbered 178." During the operations in the Gallipoli Peninsula there was a widespread epidemic of jaundice, and though we are informed that there is little clinical resemblance between the cases that occurred in the Near East and those which we propose to report in this paper it is still possible that they may have been an anomalous type of the same disease.

In Osler's "Medicine" we find "The symptoms are at first gastric, then fever follows (with the usual concomitants) and jaundice which may be slight or very intense, and as a rule albuminuria. The liver and spleen are often enlarged, and in the severe forms there are nervous symptoms and hæmorrhages. There is often a secondary fever and the attack lasts from ten days to three weeks.

The course is usually favourable, fatal cases are rare in the United States and in India and South Africa, but in the Greek Hospital at Alexandria the death rate was thirty-two among three hundred."

In 1914 Inada and Ito reported the discovery of a spirochæta in the liver of a guinea-pig which had been injected with the blood of a patient who was suffering from Weil's disease. In 1915 these authors came to the conclusion that this spirochæte was the cause of Weil's disease and later they found that the blood of patients recovering from Weil's disease contained protective substances against the spirochæta they had found. Further they showed that when they injected the blood of patients with Weil's disease during the first five days of the disease into the peritoneum of a guinea-pig, the animal developed albuminuria, pyrexia and jaundice, and they were able to show the spirochætæ in the liver and blood of the animal in large numbers. They were able to pass the infection from animal to animal and in one strain they had reached fifty generations.

The experiments made with normal people and patients with catarrhal jaundice produced no such result. Subsequently the Japanese workers were able to show the same spirochætæ in six specimens of patients' blood, in the intestinal wall in one case, and in the adrenal glands in another case of eleven autopsied cases. In two cases which came to autopsy on the sixth day of illness they found the spirochætæ in the liver in almost as great numbers as in the liver of the guinea-pig. They have with the blood of thirteen of a series of seventeen cases of Weil's disease succeeded in producing the disease in guinea-pigs, the animals showing the typical signs of the disease and the spirochætæ being found in the blood and liver of the animals. They state that the blood of all cases taken on the fourth or fifth day of illness gives positive inoculations and after the fifth day the results are inconstant as the disease progresses. They indicate that the spirochætæ disappear from the blood of the patients coincidently with the appearance of an immune substance in the blood of the patients. In the early stages they state that the spirochætæ are in the blood-stream and as the illness progresses they disappear, and they have been unable to demonstrate them in the tissues. At some period after the tenth day the spirochætæ appear in the urine and they have been able to demonstrate them both by dark-ground illumination and by animal inoculation. The appearance of the spirochætæ in the urine is a consequence of the appearance of the immune substance in the blood. They have been able to find the spirochætæ in the urine as late as the thirtieth day.

Mode of Infection.

Weil believed that the infection was through the alimentary canal. Inada supports this view. Ido and Ohi have noticed that the disease sometimes begins with a local swelling of the lymph glands and they further have been able to communicate the disease to animals by applying infective material to the uninjured skin; this leads them to think that there is a possibility of the infection occurring through the skin exposed to infected material. In support of this they found that the disease was frequent in men working in a certain part of a coal mine and that when the accumulated water was pumped out on their suggestion there were no further cases in that part of the mine. They also noted that there are more cases in wet mines than dry mines and that men working on the surface did not contract the disease. Though this does not show that the infection is necessarily through the skin it makes it worth considering and is important from the point of view of soldiers working in the trenches. They say that from their clinical cases infection from man to man is rare. There is the further possibility of the infection being carried by mosquitos or vermin, and on this point they state that they do not think that it occurs, though the reasons for this conclusion are not very clear.

Our attention was first called to the disease by a fatal case of jaundice which was under Captain Flood, R.A.M.C. He has given us permission to mention the case. The man was admitted with a temperature of 105° F. and very deep jaundice. On the evening of admission there was severe epistaxis which necessitated the plugging of the nares; hæmorrhagic diarrhœa set in, and on the third day after admission the trunk and limbs were covered with hæmorrhagic petechiæ; death followed on the next day. Post-mortem multiple hæmorrhages in the pleuræ, pericardium and peritoneum were the most striking thing, the bile passages were free and the duodenum was normal. This is the only case that we have seen in which the hæmorrhages were of anything more than a trivial degree and in this case they were apparently the immediate cause of death. At the time no guinea-pigs were available and the tissues for microscopic examination were unfortunately lost by one of us (A.S.). An emulsion of the liver was examined by dark-ground illumination and no spirochætæ seen. A second fatal case occurred a few days later, the patient being admitted under Major Young, R.A.M.C., in an advanced state of toxæmia, and he succumbed during the night after a slight hæmatemesis. Autopsy revealed no marked hæmorrhages and except for the very extreme jaundice there was nothing

to find, the duodenum and bile passage showing nothing abnormal. The liver and kidney were examined by Professor Laidlaw and he tells us that he was unable to demonstrate the spirochætæ. The case terminated on the twelfth day and the absence of spirochætæ is in accordance with the findings of Inada and his collaborators. About fifteen cases of Weil's disease have now come to our notice and we have been able to confirm the findings of the discoverers of the pathogenic cause of the disease; in two cases we have infected animals and they have shown the characteristic pathological changes and we have been able to demonstrate the spirochætæ.

General Clinical Picture of Weil's Disease as it occurred in the Cases reported.

The earliest cases that have come under our notice have been one on the fifth day of illness and four on the sixth day; the latest case was admitted on the tenth day. With the exception of one case, all the men were, or had recently been employed in the trenches at the time of the onset of the disease. In four instances more than one case occurred in the same unit. They gave a uniform history of onset, and all the men knew accurately the day on which they first fell ill; this indicates the acuteness of the inception of the symptoms.

The characteristic symptoms have been generalized pains in the head and lower limbs. The patients complain of weakness and of feeling as if they had been beaten all over, and they are reluctant to move their arms or legs. They frequently complain of severe pain in the eyes, some have complained of vague unlocalized abdominal pain. In the majority the pains appear to be muscular, the patient is unwilling to have his arm extended for the purpose of taking blood. In one case the pain has apparently been most felt in the tibiæ. All the patients on admission were very weak, and complained of the early feeling of unsteadiness and inability to stand. One man was found in a fainting condition in the latrine, and another fainted in the trenches and was unable to walk. Most of the men say that they have been vomiting repeatedly, and in a few cases they say that they have thrown up blood. Some of the patients say that they have had nose bleeding, but this is not very common.

We have only in three cases any evidence as to the early temperature. In one case we have only the patient's word for it, but he was very clear that the temperature on the first day of his

illness had been 106° F. In the other two cases we have good evidence that the onset was accompanied by a temperature of 103° F.

In only one case was the patient aware of the day on which jaundice appeared, and he dated it as the fourth day of illness. In two other cases the regimental medical officer told us that the men were not jaundiced when he last saw them on the third day of illness.

On admission the most striking characteristic is the jaundice and the extreme injection of the conjunctivæ, accompanied by great prostration.

Alimentary System.—The tongue is very dry, brown, and fissured. We have seen hæmorrhagic herpes labialis in five cases. Abdominal examination revealed enlargement of the liver in only one case, and in no instance was there enlargement of the spleen. All the patients were constipated. The stools were of normal colour and bulk. In some of the cases there was blood in the dejecta. Vomiting in the early stages occurred in every case. Diarrhœa was not noted in any case. Appetite, which was lost during the period of pyrexia, returned as soon as the jaundice began to fade. Hiccough occurred in the two most severe cases; one of these terminated fatally. One fatal case had uncontrollable hæmorrhagic diarrhœa, and in one other case traces of blood were passed by the bowel.

Circulatory System.—The pulse-rate was, as a rule, slow in proportion to the pyrexia, and there was very definite slowing during the convalescence. In two of the more severe cases there was a rapid pulse during the first week. The tension and volume was good even latterly in the fatal case. There was no evidence of cardiac dilatation.

Respiratory System.—There was no evidence of respiratory complications, but in the acute stage a little blood-stained sputum was noted. In two cases in which hiccough occurred a peculiar catchy type of inspiration was at times observed.

Excretory System.—Two cases had difficulty in micturition, for which there was no obvious cause. The urine contained bile, and there was a slight albuminuria during the pyrexial period in all cases. Acetone was found in the urine of the fatal case.

Nervous System.—Sleeplessness due to the severe pains was common in the early stages; in the more grave cases torpor was noted, and in one fatal case this progressed to the "typhoid state," with rambling delirium and muscular tremors. Pruritus due to the jaundice occurred in three cases.

Lymphatic System.—All cases showed enlarged glands. The pectoral group of the axillary glands were most often felt as discrete shotty nodes on the thoracic wall of the axilla. Glands in the neck and groin were also felt, and these were sometimes tender on pressure. The spleen was never palpable, and percussion did not show an enlarged area of dullness.

The Skin.—Varying degrees of jaundice were seen; it was usually of a lemon or orange tint, and never approached the greenish colour of obstructive jaundice. The colour rapidly increased, and as rapidly decreased as convalescence began. The degree of jaundice was not constant for two consecutive days, and was always most striking in the severe cases. The appearance of the jaundice, as far as we know, is on the fourth day. Petechial hæmorrhages only occurred in one fatal case.

The Fever.—All cases showed an irregular pyrexia descending by lysis. Subnormal temperature was common in early convalescence and also preceded death in one case. A few cases presenting all these symptoms with the exception of jaundice were seen, but in the absence of the jaundice they were not investigated.

From the cases that have been observed it would appear that there are both mild and very severe types of Weil's disease. The jaundice, weakness and pain in some of the cases have been slight and not of long duration. On the other hand there have been three deaths, and at least two other cases have been very ill.

The following are short clinical notes of the individual cases, with temperature charts attached.

Case 1.—70311 Pte. R., aged 19. Under Captain Ryle. Admitted May 13, 1916, on the sixth day of illness with the following symptoms and signs. Jaundice, pains in the abdomen, head and limbs. Dry furred tongue, conjunctival injection. Enlarged and painful axillary glands. Liver dullness normal, spleen normal. No other definite physical signs. Epistaxis, hæmorrhagic sputum, hæmorrhagic herpes labialis. Slight albuminuria, difficulty in micturition.

A guinea-pig inoculated intraperitoneally with blood taken on the sixth day developed jaundice on the seventh day after inoculation, and spirochætæ were found in the liver emulsion by darkground field illumination.

Case 2.—16275 Cpl. G. Under Major Young. Admitted May 18, 1916, with jaundice and temperature 102·8° F. Onset May 11, 1916: temperature 103° F., giddiness, vomiting, abdominal pain, general malaise. No hæmorrhages. May 12, 1916: temper-

ature normal. May 13, 1916: temperature, morning normal, evening 104° F. Sent to F. A. Date of onset of jaundice May 16, 1916. May 18, 1916: conjunctival congestion, glands not enlarged, breathing short and grunting, aching pains in limbs and head. Slight tenderness over liver, spleen not enlarged. May 19, 1916: jaundice more marked, blood in sputum and epistaxis. Glands of groin and axilla enlarged. Urine showed bile and albumen. May 20, 1916: vomited twice without cause. Brown furred tongue. Fæces normal in colour. May 23, 1916: jaundice fading. Convalescence uneventful.

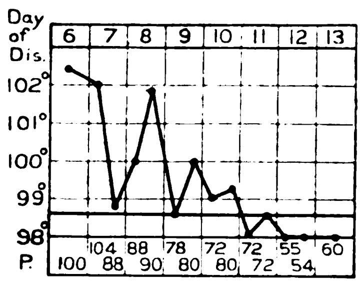

Chart 1.

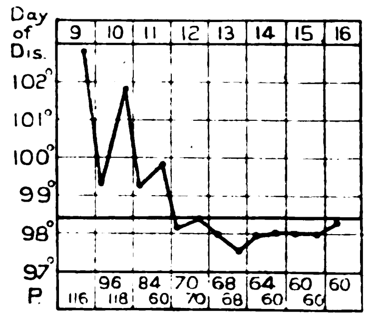

Chart 2.

No spirochætæ found in blood or urine. Guinea-pig injected on the sixth day was negative.

Case 3.—163599 Pte. H. Under Captain Ryle. Admitted May 19, 1916, on the tenth day of illness with marked jaundice, general malaise, headache, pains in the legs. History of gradual onset with vomiting. He had distressing hiccough and catchy respiration. The pains in the legs were severe, conjunctival congestion very marked and glands palpable. Liver not enlarged, spleen not palpable, very dry furred tongue. No hæmorrhages. Urine showed albumen and bile. Stools normal, May 21, 1916: mental confusion, very gravely ill, "typhoid state." Inability to micturate. Blood culture negative. May 22, 1916: rambling delirium, jaundice more marked, retching and vomiting, pruritus and catchy respiration. Attack of dyspnœa. Incontinence. May 23, 1916: muscular twitchings. Two pints of saline intravenously. Acetone in urine. May 24, 1916: death. Postmortem: extreme jaundice, two small hæmorrhages in the mesentery. Bile passages patent and bile in the intestine. Polypi in the stomach and a pedunculated polypus from which there had

been hæmorrhages near the pyloric end, which looked like a thrombosed pile. Kidneys enlarged, jaundiced and with multiple hæmorrhages. Spleen small. Heart very flabby.

No animal inoculations. No spirochætæ found in blood or urine though repeatedly examined. Emulsions of liver and kidney showed no spirochætæ when examined by dark-ground illumination.

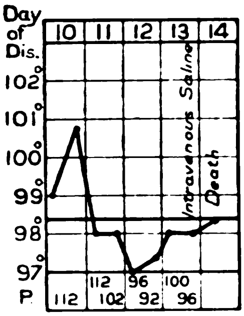

CHART 3.

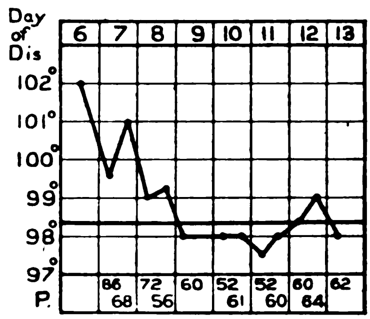

CHART 4.

Case 4.—458626 Pte. B., aged 27. Under Captain Ryle. Admitted on the sixth day of disease with intense jaundice, generalized pains especially severe in the limbs and head. Vague abdominal pains, history of vomiting. Very dry furred tongue. Liver and spleen showed no enlargement. No hæmorrhages. Conjunctival congestion very well seen. Urine showed no albumen; on the eighth day albumen was present. His jaundice increased somewhat and then rapidly disappeared until he was almost normal in colour on evacuation.

Guinea-pig inoculated with 2½ cubic centimetres of blood did not develop jaundice. One spirochæta was seen in the blood on the sixth day by dark-ground illumination.

Case 5.—12706 Pte. R. Under Captain Ryle. Admitted sixth day. Gave history of generalized pains, vomiting, and on one occasion temperature of 106° F. Found unconscious in the latrines one day. On admission had profound jaundice, headache, dizziness, pains in abdomen and limbs, and a very brown dry tongue. Conjunctival congestion; spleen and liver not apparently enlarged. Albumen in urine, no diacetic acid or acetone. Weakness and malaise very marked on admission. On eighth day of illness patient had 0·3 gramme of salvarsan intravenously which had no apparent effect on the symptoms or course of the disease.

Jaundice increased progressively till the ninth day and then gradually disappeared. Epistaxis on the ninth day. No other hæmorrhages occurred throughout the course of his illness. Blood count on fourteenth day gave 6,000,000 red cells. Hæmoglobin seventy-three per cent. Evacuated on fifteenth day convalescent.

Guinea-pig inoculated on the sixth day became ill on the seventh day and was killed on the ninth day. No jaundice occurred in the animal, spirochætæ were found in the liver and blood in large numbers. The pathological changes in the animal were typical. Plasma of the patient examined for spirochætæ on the sixth showed them both by dark ground illumination and stained by Giemsa stain.

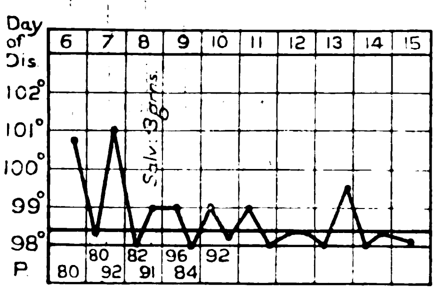

CHART 5.

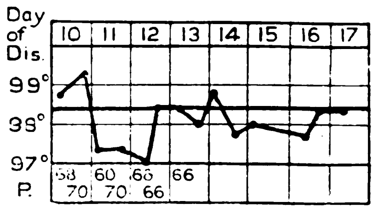

CHART 6.

Case 6.—40C971 Pte. B. Under Captain Ryle. Patient admitted on the tenth day and gave history of having fallen sick with bilious vomiting while in the trenches. Generalized pains and weakness. No albumen in the urine when he was admitted, no positive signs except jaundice, which was slight in degree, and history of pains and weakness. After the first day his temperature was subnormal.

No animal inoculation.

Case 7.—17006 Pte. G. Under Captain Ryle. Admitted sixth day of illness with history of vomiting at onset and jaundice appearing on the fourth day, which the patient states to have been his worst day. He also gave a history of epistaxis and blood-stained sputum. Generalized pains. On admission deep jaundice and extreme injection of the conjuctivæ; axillary glands and posterior cervical group also enlarged. Headache, vague abdominal pains and hiccough. Spleen not enlarged, liver slightly enlarged and tender. Vomited for three days and had very severe pains in the shins. He was very gravely ill and had deeper jaundice than any other case in the series. The urine contained a trace of albumen.

On the ninth day a little blood-stained mucous was passed from the bowel, but the motions were hard and scybalous. Rectal salines given daily. Patient remained seriously ill up to the fourteenth day, when he seemed better. Jaundice still very deep.

Two guinea-pigs inoculated on the sixth day with negative result. No spirochætæ found in patient's blood or urine.

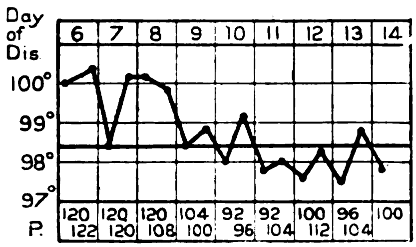

CHART 7.

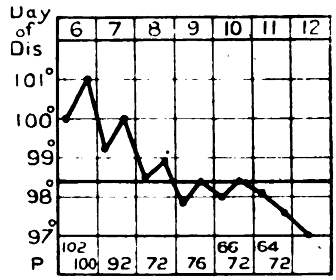

CHART 8.

Case 8.—477192 Pte. C. Under Captain Ryle. Admitted on sixth day of disease with history of shivering at onset and vomiting on one or two occasions. Generalized pains. On admission jaundice, injected conjunctivæ, hæmorrhagic herpes labialis, dry brown tongue, axillary glands palpable; trace of albumen in the urine. Very ill. Jaundice increased for two days and then began to decrease. On the ninth day he was much better and convalescence was uneventful except for the great weakness.

Two animals inoculated with negative results. Urine and blood negative by direct examination.

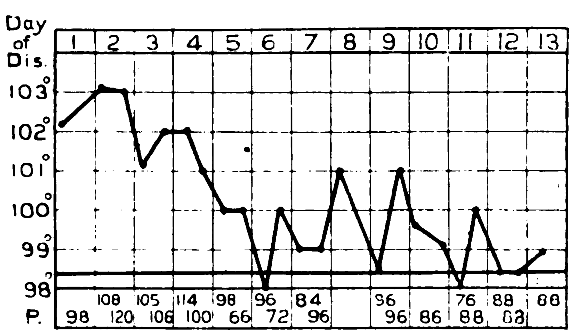

CHART 9.

Case 9.—478531 Pte. M., under Captain Ryle. Admitted on the eighth day with history of shivering at onset followed by pains in

the limbs and head. No account of hæmorrhages. On admission deep jaundice, slight conjunctival congestion, hæmorrhagic herpes labialis. Urine contained a trace of albumen, no enlargement of spleen or liver. Constitutional symptoms slight and jaundice decreased from day of admission.

Animal inoculated was negative. Urine: no spirochætæ found by direct examination.

Case 10.—24839 Pte. H., under Lieutenant O'Connor. Admitted fifth day of illness with history of onset in trenches characterized by extreme weakness in the legs, no hæmorrhages. On admission jaundice, brown furred tongue, great prostration, very severe pains in the limbs, head and eyes. Sixth day, jaundice very pronounced, still more so on the seventh day, but began to fade on the eighth day. Hæmorrhagic herpes labialis. Patient was very torpid throughout.

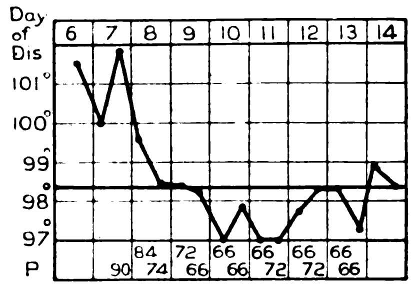

CHART 10.

Animal inoculated on the fifth day is not yet ill on the seventh day after inoculation. No spirochætæ found in the plasma on the sixth day. Urine negative by direct examination.

Experimental.—Inada, Ido and Oki injected the blood of patients with Weil's disease into guinea-pigs, and of seventeen inoculations had thirteen positive results. They do not state how much blood they injected or how many animals were used for each experiment. We have had only two positive results in animals from the blood of patients. In each case the guinea-pig was found to have the spirochætæ in large numbers in the liver and blood. The following is a table showing the injections made into animals, the day of disease on which the blood was taken, and the amount of blood used :—

Name	Day	Amount	Animals	Result
70311 Pte. R.	6th ..	2½ c.c. ..	1 ..	Positive.
16275 Cpl. G.	8th ..	2½ ,, ..	1 ..	Negative.
458626 Pte. B.	7th ..	2½ ,, ..	1 ..	,,
12706 ,, R.	6th ..	2½ ,, ..	1 ..	Positive.
11784 ,, J.	9th ..	7 ,, ..	1 ..	Negative.
47007 ,, G.	6th ..	3½ ,, / 7 ,, ..	2 ..	,,
477192 ,, C.	6th ..	3½ ,, / 7 ,, ..	2 ..	,,
478531 ,, M.	9th ..	7 ,, ..	1 ..	,,
16859 ,, C.	8th ..	3 ,, ..	1 ..	Negative on 7th day.
24839 ,, H.	5th ..	5 ,, ..	1 ..	,, ,, ,,

It will be seen from the above that two of the four experiments done on the sixth day of illness were positive, and no positive results were obtained after the sixth day. The infected guinea-pigs became ill, on the fifth day after injection in one case, and on the seventh day in the second case. They were quiet, easy to catch, and stayed in a hunched-up manner in the cage. The temperature went up to over 104° F. in each case, as is seen on the charts.

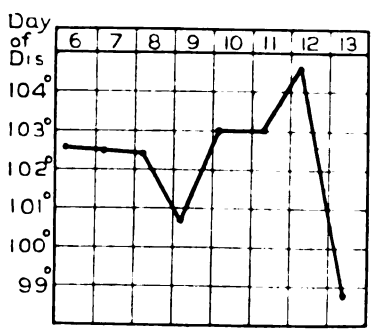

Chart 11.

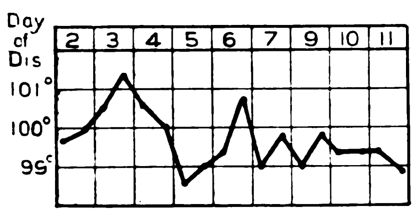

Chart 12.

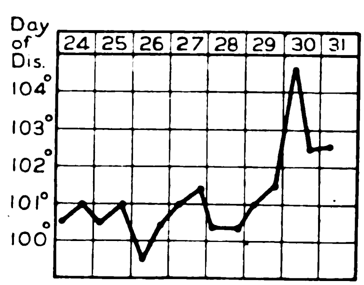

Chart 13.

The infected animals were killed and a post-mortem examination done immediately. They both showed the typical pathological

changes. To quote from the Japanese workers, "The lungs present small and large hæmorrhagic spots, like the wings of a mottled butterfly. This change is one of the most important in the diagnosis of the disease." The description of the lungs is very good and they resemble nothing more than a very gaudy butterfly. The intestines of the two animals both showed the hæmorrhages in the intestines. One of the animals had very deep jaundice, in the other there was no evidence of jaundice. Emulsions of the liver were made and examined with dark-ground illumination and very numerous spirochætæ were found. They were rather straight and with curves resembling those seen in *Spirochæta refringens* rather than those seen in *S. pallida*. The spirochæta might be described as a small replica of *S. refringens* both in shape and movements. The screwing movements of *S. pallida* were not well seen, but the movements from side to side of one end, as described by Inada, were very well seen. The length of the organism varies very much, long forms being more frequently seen, though short forms also occurred. With the dark-ground illumination they appeared somewhat granular and seemed to be composed of closely packed refractile particles. In smears made from the liver emulsion the spirochætæ were seen stained with Giemsa stain; they were, for the most part, rather straight and with a hook at one end: some good spiral forms were seen and some were slightly granular. They stained a pinkish-violet colour and except in specimens stained for long periods they were rather hard to define. We found that with the specimen of Giemsa which we were using about forty hours gave the best results. In some places they were found in groups of four or five with the appearance of being looped together. They appeared to be somewhat longer than a red corpuscle and about as thick as a typhoid bacillus. Sections of the liver and kidney of both animals stained by Levaditi showed the spirochætæ very well, in the liver they occurred in very large numbers and in the kidney perhaps not more than three or four were found in a field.

We have not yet attempted to cultivate the spirochætæ but hope shortly to do so. We have examined the urine of all the cases up to date but have not, so far, been able to find the spirochætæ in them. This may be on account of the comparatively early date on which the patients are evacuated to the base. The experiments of infecting guinea-pigs with the urine of the patients are not yet complete. The Japanese authors state that after the fourteenth day the spirochætæ appear in the urine of the patient,

and they have succeeded in five out of fifteen experiments in infecting animals with the urine. The examination of the blood of the patients for spirochætæ was done in six cases and in only one were they easily found. In this case the blood was citrated and allowed to stand and then the plasma centrufugalized and examined with the dark-ground stage and also by staining; the spirochætæ were seen moving and also stained, and the guinea-pig infected with this blood gave a positive result. In another case a single spirochæta was found with the dark-ground illumination, but as only one was found we are not very confident that it was a real organism. Reinoculation was successful from animal to animal and Professor Laidlaw informs me that he has also passed the disease from animal to animal from the first strain isolated.

Blood cultures were made in every case for the typhoid group organisms and were uniformly sterile.

In conclusion we think that the experimental facts which we have to offer are meagre but are sufficient to show that the cause of epidemic jaundice (spirochætosis icterohæmorrhagica) in Japan and in Flanders is identical. We think it also of importance that the infective possibilities of the disease should be recognized. We hope at a later date to have some more evidence to bring forward.

REPORT ON THE LATER RESULTS OF GUNSHOT WOUNDS OF THE HEAD.

By Lieutenant-Colonel P. SARGEANT and Lieutenant-Colonel G. HOLMES.
Royal Army Medical Corps.

(I) Material available for Report.

According to instructions, we proceeded to England to investigate, as far as is possible at this stage, the later results of gunshot wounds of the head, and to obtain any information which might be of service in the early treatment of these injuries.

Having reported to Sir Alfred Keogh, D.G., and having obtained from him the necessary authorization, we visited the following hospitals :—

The First London General Hospital.
The Fourth London General Hospital.
The Fifth London General Hospital.
The King George Hospital.
The London Hospital.
The National Hospital for the Paralysed and Epileptic.
The Hospital for Epilepsy and Paralysis, Maida Vale.
The Empire Hospital for Officers.

In each of these institutions we saw the patients then under treatment in the wards, and examined the notes and records of all patients who had been admitted with the diagnosis of gunshot wounds of the skull.

We also took to England a nominal roll of 700 men, almost all of whom had severe head injuries, whom we had had the opportunity of observing in France and of whose early condition and history we possess full clinical notes. Through the kindness of Surgeon-General Sir Launcelot Gubbins, who gave us access to the records of the Chelsea Commissioners, we were able to see the later medical reports on, and learn the fate of many of these patients.

We attempted also to obtain special information on the occurrence of serious complications, particularly epilepsy and insanity. In the first place we searched as far as was possible the out-patient and in-patient records of the National Hospital for the Paralysed and Epileptic, and of the Hospital for Epilepsy and Paralysis, Maida Vale, the two largest special institutions in London which treat epilepsy, and noted all cases of this condition which had

developed in men, already discharged from the Army, who had suffered from gunshot wounds of the head.

Finally, at Sir Alfred Keogh's suggestion, we visited the Napsbury War Hospital, which has received for observation and disposal from May, 1915, to January, 1916, all soldiers with serious mental symptoms, except general paralytics, epileptics and the chronically insane; and since January 1916 all cases except those occurring in the Scottish, Irish and Northern Commands.

Major F. W. Mott, F.R.S., Pathologist to the London County Council Asylums, also kindly obtained at our request, from the London County Council asylums, a return of all cases that had been admitted to these institutions with mental disease which could be attributed to gunshot wounds of the head, inflicted during the present War.

By these means we succeeded in determining the condition of 1,239 patients between two and eighteen months after the infliction of the wound; in many of these cases, however, our information is incomplete. The fact that many of them reached England without any record of the nature of the wound, or the clinical symptoms, or of the operation performed at the Front or in the Base hospitals, made them difficult to classify, and in many others there was not sufficient information available to decide upon the nature and severity of the wound. We have, however, tried to exclude from our list mere scalp wounds, unless these led to death or were followed by the development of serious complications.

After excluding scalp wounds without any bony or cerebral injury, and cases in which the nature of the injury was uncertain, as well as those in which the latest information was too recent to be of value, we still have sufficiently accurate records on 610 patients, more than seventy-five per cent of whom were seen or had been examined more than three months after the infliction of the wound.

We have, however, in attempting to estimate the percentage of mortality amongst cases of head wounds evacuated to England, included all patients who have died, at whatever interval, after their arrival.

It is also necessary to point out that information on a large proportion of the cases in our list was obtained from the records or wards of the five hospitals (the King George Hospital, the London Hospital, the National Hospital for the Paralysed and Epileptic, the Hospital for Epilepsy and Paralysis, Maida Vale, and the Empire Hospital for Officers) to which serious cerebral injuries are

sent labelled by a green ticket, and that a large number were traced through the Chelsea Commissioners, who are concerned only with wounds sufficiently severe to necessitate invaliding from the Army. There can consequently be no doubt that the cases included in our list are more severe than the average of cases diagnosed as gunshot wounds of the head.

We wish to express our thanks to the commanding officers and to the medical staffs of the hospitals which we visited, and to the Chelsea Commissioners, for the courtesy with which they received us and for the help they gave us in our investigation.

(II) Mortality after Evacuation to England.

Of the 1,239 cases of gunshot wounds of the head which have been admitted to the eight London hospitals above mentioned, forty-six or 3·7 per cent have died. This figure includes a certain number of serious and hopeless cases which were evacuated to England from the Base hospitals as quickly as possible, on whom no operation was performed, or in whom exploration showed that there was no reasonable prospect of recovery. Nine of the patients died within two weeks of their arrival at home and at least four within this period after the infliction of the wound. In the large majority of the other cases death occurred within three months; we have found records of only five patients who succumbed after this period.

It was possible to ascertain the immediate cause of death in a considerable number of these cases; in twenty-two, records of post-mortem examinations were available. In almost all spread of septic infection was the cause of death, but in a few other complications were responsible for, or contributed to, the fatal issue. One remarkable case, in which a rifle bullet entered in the right frontal region, passed through the base of the brain, ricochetted off the petrous bone and then passed through the third ventricle and the posterior third of the corpus callosum into the left occipital lobe, died suddenly three and a half months later, when the cerebral symptoms had almost disappeared, owing to the bursting of an aneurysm of the posterior communicating artery. In one case a fatal secondary hæmorrhage occurred during the journey to England, and another died from an extensive intra-cerebral hæmorrhage without intracranial infection. In two other cases pneumonia and hæmothorax were found on post-mortem examination, but in both the cerebral wounds were severe.

Eleven patients succumbed after operation in England; in two

cases after excision of the cerebral herniæ which existed; in two others after primary operations immediately on their arrival from France, in one after an attempt to remove a shrapnel ball which was lodged deeply in the brain, and in others after operations to relieve herniæ or to evacuate cerebral abscesses.

In ten of the seventeen other cases of which post-mortem records were available, death was due to meningitis, and in seven to cerebral abscesses, which in most cases had led to infection of the meninges or to spread of infection to the ventricles. In two of the cases which died of meningitis the ventricles had probably been opened by the original wound, as cerebrospinal fluid escaped in large quantities.

Thirty-four of the forty-six fatal cases had been operated upon before their evacuation to England; in six no operation had been performed, and in six other cases we were unable to obtain definite information on this point.

We have traced and have heard of no case in which death has occurred in England when the dura mater had not been lacerated by the wound and had not been opened by operation.

(III) Physical Disabilities.

The physical disabilities that result from gunshot injuries of the brain naturally depend on the severity and the position of the wound. It is impossible to deal with these statistically, and as yet, due especially to the fact that the award of pensions is only conditional, the wage-earning capacity cannot be taken as a standard.

It is generally recognized now that much of the paralysis, sensory and visual disturbances, etc., seen in the early stages is due not to local destruction of the brain, but to concussion, œdema and vascular disturbances that often extend widely beyond the primary injury. The symptoms which diminish or subside early are mainly due to these factors.

Disappearance of those symptoms due to actual destruction of brain tissue does not seem on *a priori* grounds probable in many cases, and yet we have been on the whole surprised at the amount of improvement that has later occurred. A small proportion of men with penetrating and perforating wounds of the skull whom we originally saw with paralysis, sensory disturbances, hemianopia, etc., have already returned to active service, and others are employed in wage-earning capacities. As improvement is generally slow and continuous over long periods, it may be expected that a considerable proportion of men with even severe head injuries will be able to lead useful and active lives.

The amelioration of symptoms has been especially striking in many of the cases of hemiplegia, diplegia or quadriplegia due to injury of the superior longitudinal sinus.

(IV) Neurological Complications.

The opinion has been generally held that a large proportion of the patients with severe cerebral injuries who survive would be subject to serious complications or sequelæ, particularly insanity and epilepsy. It is still too early to affirm or deny definitely the frequency of these after results, but if they were likely to be common many cases should already have occurred among the very large number of men who have returned to England with gunshot wounds of the head. As far as we have seen, however, the proportion of cases in which either insanity or epilepsy has yet developed is surprisingly small.

(1) *Insanity.*—There can be no doubt that many patients present symptoms of some degree of mental deterioration, and especially dullness, loss of memory, irritability and childishness, during the early stages after the infliction of the wound, but the reports we have obtained in the later stages, and the records we have been able to examine, tend to show that in the majority of cases these symptoms disappear or diminish.

On the other hand, serious mental disturbances or actual insanity which necessitates confinement under certificate seems to be surprisingly rare. During a period of twelve months only eight patients who had been wounded in the head were admitted with mental symptoms to the Napsbury War Hospital, the special institution to which cases of insanity attributable to conditions of service are sent for observation and disposal. Four of these had already been discharged cured, or sufficiently improved to be at large; of the rest one had been previously invalided from the Army as insane, but rejoined for the War, and a second was regarded as a case of dementia præcox which was in all probability independent of the injury. In only two cases, therefore, could the persisting mental symptoms be attributed to the head injury. Seven of these eight patients had been operated upon before their arrival in England.

Through the help of Major F. W. Mott we have received from all the London County Council Asylums returns of the number of cases of insanity associated with gunshot wounds of the head that have been admitted to them; only one case is reported, a Belgian soldier, who died from septic infection of the cerebral ventricles.

This fact is the more surprising when it is remembered that all cases of insanity in invalided soldiers who belong to the London County Council area, which includes about one-seventh of the population of the United Kingdom, are transferred or admitted to these asylums.

These facts are supported by Major Mott's weighty opinion; he writes to us: "Personally I am very sceptical of a large number of cases (of insanity) arising from traumatic causes. I went into this subject very fully some years ago, and came to the definite conclusion that head injury, apart from syphilis, alcohol and hereditary neuropathic taint, was seldom the cause of the mental affection."

(2) *Epilepsy.*—The comparative rarity of generalized or Jacksonian epileptiform seizures in patients suffering from recent head wounds has been surprising, and even in the later stages fits have been as yet less common than has been generally feared.

We have found that fits have occurred after evacuation to England in 37, or six per cent, of the 610 cases on which we have complete notes. In 8 of these, however, only one convulsion had occurred; in 12 only "a few"; 5 men are reported to have had "five or six fits"; while in only 11 were the convulsions frequent.

It is impossible to ascertain from the records at our disposal in what proportion of the cases the attacks were local Jacksonian seizures, and in how many they were general convulsions. In eight of the patients they were described as "Jacksonian," but in the others only the general term "fits" is employed.

In a considerable proportion of these cases only one or two seizures occurred soon after their arrival in England, and in several of the others they were arrested by the administration of bromide. The practice of giving bromide regularly to all serious cranial injuries until the wound is healed, and for some months afterwards, seems advisable.

In five cases secondary operations were performed with good results; in two of these small abscesses were drained and in three spicules of bone were removed.

In 33 of the 37 cases in which fits have occurred there were severe compound fractures of the skull with laceration of the dura mater and direct injury of the brain, and in 4 of these a missile was still present in the brain. Of the remaining 4 patients one had been an epileptic since 8 years of age; in 2 only a few attacks had occurred; and one had been for six, in the other for nine, months free from seizures. This patient had been wounded only two and a half months previously, and no injury was found

at an exploratory operation. In 33 of the 37 patients operations had been performed before arrival in England.

As it might be expected that if epilepsy were a frequent complication many of the men already discharged from the Army would seek relief at the special hospitals that treat this condition, we searched the in-patient and the out-patient records of the National Hospital for the Paralysed and Epileptic, but could discover notes of only two patients who had attended for epilepsy; one in whom a fragment of shell casing which had penetrated from the right occipital region to the right frontal lobe twelve months previously is included in the above statistics; the second had had only a scalp wound and developed later indefinite attacks of giddiness, which were probably epileptic, after a fall that produced cerebral concussion. Dr. Fearnsides kindly informed us that, as far as he is aware, only one case of epilepsy, a man with a gutter wound of the skull, had attended the out-patient department of the Hospital for Epilepsy and Paralysis, Maida Vale, and he had remained free from attacks since the administration of bromide five months ago.

(3) *Other Neurological Complications.*—Various forms and degrees of paralysis, sensory and visual disturbances, etc., due to the primary cerebral injury or to further damage to the brain by septic infection, hernia formation, or in the course of treatment, are naturally very common, but various subjective symptoms, which cannot be attributed to any local injury, are also remarkably frequent and necessitate the invaliding of many men from the Army. The most common of these is headache, which generally takes the form of a feeling of weight, pressure or throbbing in the head, and is increased by noise, fatigue, exertion or emotion; attacks of dizziness, and nervousness or deficient control over the emotions and feelings. Many, too, exhibit a considerable change in temperament; they are depressed, moody, irritable or emotional, and unable to concentrate attention on any physical or intellectual work. A few have had major hysterical symptoms, such as paralysis, anæsthesia, or visual disturbances.

These symptoms are very similar to those seen in neurasthenia, and especially when this condition has been of traumatic origin. They certainly incapacitate the subjects from active service, but they are, on the other hand, recoverable. They are entirely independent of the site or severity of the original wound, and are often as severe when the scalp only has been injured as in serious compound fractures of the skull, and they seem to develop equally whether an operation has been performed or not.

(V) Healing of Wounds: Cerebral Hernia.

A large number of cases of penetrating or perforating gunshot injuries reach England with the wounds still open, and many with hernia cerebri, but as a rule they heal so rapidly that among the 610 patients on whom we possess notes, and upon whom no further operation was performed, in only 19 were the wounds still open three months after their arrival in England, and in only 4 of these were they still unhealed six months after the infliction of the wound. In 3 of these 4 cases there had been large herniæ and extensive defects in the scalp and skull; 18 of the 19 patients had been operated upon abroad.

Cerebral Hernia.—One hundred and twenty of our 610 patients reached England with a cerebral hernia. Their progress and fate can be most conveniently referred to according to the different types of wounds.

(i) Ninety-six cases had had penetrating wounds with retained missiles; in 27 the missiles had been removed either in the casualty clearing stations or in the Base hospitals; 6 of these developed herniæ, of whom 2 died. Of the remaining 69 cases which were evacuated with the missile still retained, 14 developed a hernia and 2 of these died. Consequently in 20, or 20·8 per cent, herniæ occurred; in 4 of these a fatal termination ensued. In 13 the hernia had shrunken and the wound was healed when the patient was last heard of, and in 2 the herniæ were smaller and the wounds healing rapidly at periods of three and four months respectively after the infliction of the injury.

(ii) Of the 68 cases of perforating or "through and through" wounds, 14, or 20·6 per cent, had a cerebral hernia. Ten of these had been submitted to operation and 2 were operated upon again in England. Four of the 14 patients died, and in 8 of the others the wounds were already completely healed at the date of the latest information.

(iii) There are 310 cases of penetrating wounds without retained missile in our list; 86, or 27·7 per cent, reached England with a cerebral hernia. Nineteen of these died and in 49 the wounds were completely healed. Sixty-two of the 86 patients had been operated upon abroad.

Death has consequently resulted in 24·16 per cent of the cases evacuated to England with cerebral hernia.

We obtained information of 12 patients with cerebral herniæ who were operated upon after reaching England; in 9 of these a previous operation had been performed abroad. Six died, of

generalized meningitis; in 2 of these the opening in the skull was enlarged and the wound explored; in 1 a subdural abscess was opened; in another an attempt was made to remove a bullet; and in 2 cases the herniæ were excised. In the 6 patients who recovered, the operations were: "abscess evacuated" in 2 cases; "spicules of bone removed" in 2 others; while "the hernia explored" and "the hernia shaved off" were the operations in the remaining 2.

(VI) Bullets, Shrapnel-balls, and Fragments of Metal lodged in the Brain.

Ninety-seven cases of this class were traced. Of these twenty-seven had had the foreign body removed before their transference to England, but the results in these cases must be taken with much reserve, from the fact that in many the bullet or piece of metal was only just inside the skull and was removed along with the fragments of bone. Of these, 3 died (all within three months), 2 were alive and well within three months, 12 between three and six months, 8 between six and twelve months, and 2 over twelve months after the infliction of the wound.

The fate of those cases sent to England with the missile still in the brain is a matter of considerable importance, bearing as it does upon the question whether deliberate attempts should be made at any period to remove such foreign bodies. In all the cases reviewed in this connexion the foreign body was at some considerable distance from its point of entry; a few were rifle-bullets and a few were shrapnel-balls, but the great majority were smaller or larger fragments of shell, often multiple and inaccessible. We have traced sixty-nine such cases, of which four died.

The analysis of these fatal cases is interesting. Two were sent home in what appeared to be a hopeless condition, one with a large hernia and one with cerebrospinal fluid escaping from the wound, and both died within two months; one died six weeks later after an unsuccessful attempt to remove a bullet which lay close to the falx cerebri; and the fourth died from a rupture of a cerebral aneurysm, the fatal issue being wholly unconnected with the continued presence of the missile.

Of the 65 surviving cases, 12 had been wounded less than three months previously, 25 between three and six months, 21 between six and twelve months, and 7 over a year ago.

In seventy-six per cent the wounds were soundly and completely healed.

In thirty per cent, complete recovery had occurred, and no symptoms of cerebral lesion were present.

In forty per cent the neurological symptoms had improved to a remarkable extent.

In 10·5 per cent much disability (hemiplegia, hemianopia, neurasthenia, etc.) still persisted, but its existence depended on the damage done by the missile in its course and not on its presence. Fits had occurred in only four cases, and in two of these the fits were early and transient while the patients were still in France.

(VII) CASES OPERATED UPON AFTER REACHING ENGLAND.

Amongst the total number (610) of cases of which we have complete records, fifty-two were submitted to operation in England, They may be arranged in groups according to the type of wound.

(1) *Scalp Wounds*, whether with or without fracture of the skull. No operations.

(2) *Depressed Fracture without Laceration of the Dura Mater.*—Three operations as follows :—

(*a*) Removal of sequestra from wound; two cases, one of which had been previously operated upon. Both recovered.

(*b*) Sub-temporal decompression for increased intracranial tension; one case (frontal), previously operated upon at site of injury. Recovered.

(3) *Penetrating Wounds without retained Missile.*—In this group there are thirty-four cases, which may be set out according to the nature of the operation.

(*a*) Removal of sequestra from wound; ten cases, of which seven had already been operated on. All recovered.

(*b*) Drainage of cerebral abscesses; ten cases, of which seven had been operated upon abroad. Two died.

(*c*) Drainage of epidural abscess; one case, previously operated upon. Recovered.

(*d*) Removal of bony fragments from brain; two cases, one previously operated upon. Both recovered.

(*e*) Exploration of brain; one préviously operated upon; one died (three cases).

(*f*) Hernia cut off; three cases with two deaths. Two had been operated upon abroad.

(*g*) Nature of operation not stated; five cases, three previously operated upon. One died.

(4) *Penetrating Wounds with retained Missile.*—The eleven operations were as follows :—

(*a*) Removal of sequestra from wound; one case, previously operated upon. Recovered.

(*b*) Drainage of cerebral abscess; two cases, both already operated upon; both recovered.

(*c*) Removal of bony fragments from brain; one case previously operated upon. Recovered.

(*d*) Exploration of brain; two cases, both previously operated upon. One died.

(*e*) Removal of fragment of shell from brain; one case not previously operated upon. Recovered.

(*f*) Unsuccessful attempt to remove bullet from brain; two cases, one already operated upon. One died.

(*g*) Nature of operation not stated; two cases, both previously operated upon. Both recovered.

(5) *Perforating or "Through and Through" Wounds.*—Four operations as follows:—

(*a*) Exploration of brain; two cases, one previously operated upon, both died.

(*b*) Nature of operation unknown; two cases, neither of which had been previously operated upon. One died.

(6) *Summary of Cases operated upon after reaching England.*—Among the fifty-three cases tabulated above there are eleven deaths. Thirty-five patients had already been operated upon, of whom six died; in eight there had been no previous operation, and of these one died; in the remaining ten cases we could not ascertain whether there had been a previous operation or not, and four of these patients died.

The nature and results of these later operations are interesting. Thirteen were clearly of a trivial character, consisting merely in the removal of sequestra from an unhealed wound. Twelve were for intra-cerebral abscess, and it is very remarkable that ten of these patients should have recovered, especially in view of the very much higher rate of mortality in cerebral abscess of otitic origin. In only three of the cases so far had an operation been performed for the removal of a projectile; one proved unsuccessful and the patient succumbed; in a second the attempt was also unsuccessful, but the patient did not die; the third was successful and the patient recovered. In three cases a cerebral hernia was shaved off; two of the patients died of meningitis, whilst the third, although cerebrospinal fluid escaped for some time after the operation, fortunately survived; he still has a hernia cerebri.

Conclusions.

We recognize that a certain margin of error is possible in the observations and conclusions presented in this report, but we have

attempted to exclude all cases on which sufficient facts were not available, and those in which the wound was too recent to warrant definite conclusions on the fate of the patient. The information obtained has been presented as objectively as possible.

The later results of head wounds seem to be much more satisfactory than had been generally expected; the proportion of patients who die after transference to England is small; later complications such as cerebral abscesses are relatively rare, and serious sequelæ, as insanity and epilepsy, are as yet much less common than has been foretold. It must be recognized, however, that a large percentage of the patients dealt with in this report have been seen or heard of within some months only after the infliction of the wound. In only fifteen per cent of them have we been able to learn their condition after more than one year. But even such facts as are available are a safer guide than opinions based merely on *a priori* reasoning.

It should be also remembered that the cases on which this report is based were on the average more serious than the total of cases transferred to England with the diagnosis of "gunshot wounds of the head," since our records were collected mainly in the special London hospitals to which severe neurological cases are sent. Further, we have included in our list cases in which death or serious complications ensued, even when the records on the nature of the wound scarcely warranted inclusion.

One of the chief conclusions that can be drawn is that there are no grounds for supposing that more radical operations abroad are called for. It seems extremely doubtful if surgical intervention other than that necessary for the drainage and healing of the wounds diminishes appreciably the risk of later complications, or can modify, except in a harmful direction, the course of these cases from the functional standpoint. Every possible step should, however, be taken to prevent the development of a hernia cerebri.

Our records also show that many patients with foreign bodies lodged deeply in the brain recover, and are scarcely more liable to serious complications than men in whom the brain has been merely exposed and lacerated. Any attempt to remove them which may involve spread of infection or further destruction of brain tissue is consequently inadvisable.

From the point of view of further treatment and in the interest of the patient we would emphasize the importance of brief clinical notes, dealing particularly with the early state and treatment, being sent to England with each patient.

EPIDEMIC CEREBROSPINAL FEVER: THE PLACE OF THE MENINGOCOCCUS IN ITS ETIOLOGY.

(*Fourth communication.*)

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AND

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EARLY in the year 1915 I showed that [2] in order to determine the true bacterial content of the cerebrospinal fluid in acute cases of cerebrospinal fever it is often essential that the fluid should itself be used as the medium of growth, at all events in the early stages of its examination. In so far as the isolation of comparatively large and easily cultivable organisms, such as the meningococcus, is concerned, this necessity, in certain cases, for the incubation of the fluid itself has been amply confirmed by numerous observers[9].

But in conjunction with Dr. C. E. Lakin and Dr. T. H. C. Benians I had also shown [3] that for test tube demonstration of the presence of very minute forms of bacteria, which are not necessarily amenable to cultivation on synthetic media, incubation of the fluid itself as the medium of growth was in many cases equally necessary. And this particularly applied to the routine demonstration of certain minute organisms we described, which were of so small a size that their morphology was often indeterminable, and which we thought might prove to represent early stages in the development of the meningococcus.

The theory that the meningococcus represents merely a phase in the life-history of the causal organism of cerebrospinal fever is part of the larger question which I have raised elsewhere[4], whether certain bacteria do not exhibit a complex life-history somewhat similar to that which obtains amongst the protozoa, and to that which appears to obtain amongst the spirochætes. The present communication will not deal with this theory, which is only referred to here in order to draw attention to the fact that it was the possibilities involved by the theory which originally led Dr. Lakin, Dr. Benians and myself, in the epidemic of 1914-15, to

search for bacteriological evidence of filtrable micro-organisms in this disease, and which subsequently prompted me to put the matter to experimental test.

The results of these experimental tests, published in the present year [5], were that I was able to show that it is possible, under favourable circumstances, to demonstrate in the cerebrospinal fluid of acute human cases of the disease the presence of a pathogenic agent capable of passage through Chamberland F bougies. The pathogenic effects of this filter-passing agent when injected into monkeys by the peritoneal route included continued fever and death. And I was also able to show that injection of other monkeys with cerebrospinal fluid taken from acute cases of the disease produced no demonstrable pathogenic effect, notwithstanding the fact that living meningococci were cultivated in large numbers from the fluid injected.

From these experiments the conclusion appeared to be justified that it is probably not the meningococcus as such which is directly responsible for the disease cerebrospinal fever, that the filtrable virus described might prove to be causally related to the disease, and that fresh investigation was necessary in order to determine the point, as well as the further question whether a genuine biological relationship does or does not exist between this virus and the meningococcus of Weichselbaum.

As already stated, the present communication will not deal with the question of biological relationship between the meningococcus and the filter-passing virus referred to. But the results already obtained as regards the existence in this disease of a pathogenic filter-passing virus, and the apparent harmlessness of the strains of meningococci injected in cerebrospinal fluid, made further investigation desirable, especially as the number of animals injected was admittedly small. Necessity for reinvestigation of the etiological claims of the meningococcus of Weichselbaum was also accentuated by the fact that a critical analysis [6] of the evidence in its favour had shown it to be of a wholly unconvincing nature, quite apart from the counter-evidence mentioned above.

After consultation, therefore, with the Directors-General of the Naval and Military Medical Services, who, in view of the practical possibilities involved, kindly undertook to provide the necessary clinical material for the purpose, I decided at the beginning of the present epidemic to pursue the investigation on a larger scale than had hitherto been feasible.

Before presenting the following results of this further investiga-

tion—which is still being carried out—I wish to record my indebtedness to Sir Arthur May, Director-General of the Naval Medical Service, for the perfect organization which enabled us to obtain material within a few hours of the onset of the disease, to the staffs of the Naval Hospitals at Plymouth and Haslar (especially to Fleet Surgeon Whiteside, Royal Naval Hospital, Plymouth), and to the civilian staff of the Croydon Isolation Hospital (receiving naval cases from the Crystal Palace) for their generous co-operation. I wish also to express my sincere thanks to Sir Alfred Keogh for his unfailing interest in the work and for the laboratory facilities he has allowed us to take advantage of at Addington. And I desire further to express my thanks to Surgeon-General Carlton Jones, Director-General of the Canadian Medical Service, for the material he kindly authorized us to use and for his ready consent to detail Captain A. H. Caulfeild, C.A.M.C., to join me in the work, without whose valuable aid it would have been difficult to carry on the extensive observations contemplated. And, finally, I desire to acknowledge the hospitality of the Governing Body of the Lister Institute, and to record in particular our gratitude to Professor Adami for the generous help and advice he has given us throughout.

EDWARD C. HORT.

EXPERIMENTAL OBSERVATIONS.

The animals injected are divided into the following groups for convenience of description and of analysis of the results obtained. For the sake of completeness and of clearness in the interpretation of the phenomena involved, we have included amongst the animals injected with cerebrospinal fluid in Groups IA, IB, IC, ID, eight animals previously experimented upon, data as to which have already been published. These animals are marked with the letter H. For all other data here recorded the authors are jointly responsible, with the exception that in Groups II and V one of us (Hort), and in Groups III and IV the other (Caulfeild), has alone conducted the work supplying the bacteriological observations and experimental data.

The following general observations apply to the subjoined groups:—

(1) In all the human cases providing material for injection the meningococcus was isolated from the cerebrospinal fluid at some time during the course of the disease—though not necessarily from the sample injected—and in each case the classical biochemical and

serological tests were fully satisfied. In all these cases the fluid injected was obtained during the life of the patient.

(2) It was found that cultural tests such as the inability to grow at room temperature and on non-albuminous solid media were quite unreliable in the case of many strains, the identity of which was biochemically and serologically indisputable.

(3) The action of chloroform vapour for four hours, as well as preservation at cold room temperature for from one to three days, did not prevent the ultimate isolation of the meningococcus from the cerebrospinal fluid of acute cases so treated.

(4) Serum-agar and serum-broth were the media mainly used, the horse serum being in all instances thoroughly tested by control cultivation experiments for sterility with regard to both visible and invisible organisms. The serum was delivered from a graduated distributor, so that known volumes could conveniently be used for each culture.

(5) Control single intraperitoneal and subcutaneous injections of monkeys with serum-broth and saline respectively had been shown by one of us (Hort) in 1915 not to produce continued fever or death. In addition to this, during the course of the present work, two monkeys receiving each an injection of serum-broth, containing approximately ten to twelve cubic centimetres of serum —the highest dose of serum given throughout—remained unaffected.

(6) Whenever the supply of animals permitted, the internal body temperature was taken twice daily for some weeks before injection.

(7) The upper normal limit of the daily range of the temperature of the three species of monkeys obtained for experiment had been found by one of us not to exceed about 102·4° F. in approximately 150 monkeys.

(8) All the filters used in these experiments were prepared, tested and assembled in the manner elsewhere described [7] by the same observer [4].

(9) In all cases control samples of the cerebrospinal fluid examined for the presence of the meningococcus were incubated both before and after inoculation of solid media and of serum-broth. In no instance, when the solid media so inoculated remained without growth, was the sample declared sterile quâ the meningococcus until repeated negative results had been obtained on solid media from the incubated cerebrospinal fluid or from the primarily inoculated serum-broth. In several instances it was shown that the incubated cerebrospinal fluid gave positive results

when the solid media inoculated from the fresh fluid remained sterile.

(10) This control was also applied to the isolation of organisms other than the meningococcus from the cerebrospinal fluid, organisms which, because of their character and of the frequency of their occurrence in fluid collected under good conditions, cannot reasonably be looked upon as contaminations in the ordinary acceptation of that term. The Gram-variable diplococcus of Jaeger, the meningo-bacillus and, more rarely, chromogenic Gram-negative diplococci are cases in point.

(11) In the majority of cases providing cerebrospinal fluid, not marked with the letter H, the fluid was collected within the first few hours of the appearance of symptoms, before the inception of specific treatment. These cases are marked with the figure 1 occurring after the number or letter used to designate the individual from whom they were obtained.

(12) The administration of antiserum or of vaccine was in certain of the cases followed by failure to cultivate the meningococcus from the cerebrospinal fluid, although the organism had been cultivated and identified from specimens obtained before injection. These cases are differentiated from the former by the figure 2 occurring after the number or letter used to designate the individual from whom they were obtained.

GROUP IA.

INJECTED WITH FRESH UNFILTERED CEREBROSPINAL FLUID CONTAINING NO VISIBLE MENINGOCOCCI AT THE TIME OF INJECTION.

Number of animal	Number of case and specimen	Number of cubic centimetres injected	Route of injection	Period of observation	Meningocci cultivated from control specimen of injected cerebrospinal fluid	Result
52	5 (1)	16·5	Skin	45 days	Yes	*Nil.*
59	8 (1)	20·0	,,	51 ,,	,,	Continued fever.
44	5 (2)	6·0	,,	16 ,,	,,	Death.
43	6 (2)	12·0	,,	12 ,,	No	,,
79	10 (2)	13·0	Peritoneum	14 ,,	,,	Continued fever and death.

Total number of animals injected, 5. Fever-rate, 40 per cent; death-rate, 60 per cent; total pathogenic rate, 80 per cent. Average volume of cerebrospinal fluid injected, 13·5 cubic centimetres.

Analysis of these results shows:—

(1) That a high pathogenic rate was produced (particularly in contrast to that shown in the comparable Group Ic), although

meningococci could not be demonstrated in the cerebrospinal fluid by immediate film preparations made from the centrifuged deposit or supernatant fluid, and in spite of the fact that in two of the specimens laboratory cultivation was not successful. At first sight the positive cultural results obtained in the case of Animals 59 and 44 suggest that the pathogenic effect produced can be directly attributed to the action of living meningococci. But if this explanation were correct, Animal 52 should logically have shown some ill-effect, especially in view of the fact that the same sample of cerebrospinal fluid, when rendered meningococcus-free by filtration, caused death (Group Iв, Animal 53).

This explanation—viz., pathogenic action of living meningococci—is, moreover, quite inadequate in the case of Animals 43 and 79, since no meningococci could be cultivated from samples of the specimens injected.

GROUP Iв.

INJECTED WITH FILTERED CEREBROSPINAL FLUID IN WHICH NO MENINGOCOCCI COULD BE DEMONSTRATED BY LABORATORY CULTIVATION.

Number of animal	Number of case and specimen	Volume of cerebrospinal fluid injected	Route of injection	Period of observation	Meningococci cultivated from control specimen of unfiltered cerebrospinal fluid	Result
57	6 (1) in 24 hours	2·0 c.c.	Peritoneum	39 days	Yes	*Nil.*
55	6 (1), fresh	6·0 ,,	,,	5 ,,	,,	Death.
53	5 (1), ,,	4·5 ,,	,,	24 ,,	,,	,,
63	8 (2), ,,	10·0 ,,	,,	43 ,,	No	Fever and death.
58	7 (1), ,,	7·0 ,,	,,	54 ,,	Yes	Continued fever.
80	10 (2), ,,	13·0 ,,	,,	35 ,,	No	Continued fever.
82	11 (1), ,,	7·5 ,,	,,	40 ,,	Yes	Continued fever.

Total number of animals injected, 7. Fever-rate, 57·2 per cent; death-rate, 72·9 per cent; total pathogenic rate, 85·8 per cent. Average volume of cerebrospinal fluid injected, 7·0 cubic centimetres.

Note.—The unfiltered cerebrospinal fluid contained visible meningococci in the case of Animals 57, 55, 58, 82, but not in the case of Animals 53, 63, 80.

It therefore seems difficult to ascribe the high pathogenic rate produced in this group to the action of living meningococci as such. The post-mortem results obtained in the case of Monkey 43 show the presence of streptococci, but inasmuch as death was not preceded by any fever it is possible that this was an added pre-agonal

infection. Unfortunately, in the post-mortem record of Monkey 44, no mention is made of bacteriological examinations.

(2) That the continued fever occurring in Animal 79 cannot be explained by the primary action of meningococcal toxin present as such in the fluid injected, since there is no preformed bacterial toxin known to us a single injection of which is directly capable of producing continued fever lasting for weeks. The force of this argument regarding duration of fever is better illustrated in the ensuing groups (especially Group IB) in which, as will be seen, fever followed injection for periods of several weeks. The negative post-mortem bacteriological results obtained in these cases of continued fever should exclude the possibility of the rise of temperature being due to a secondary infection, however brought about.

The points to which it is desired to draw special notice in Group B are :—

(1) A new Chamberland F bougie was employed in each case.

(2) The inoculum was withdrawn from the filter flask *before* its enrichment with the volume of serum-broth necessary to ensure a suitable medium for growth of the meningococcus. By repeatedly proving the sterility of the filtrate as regards visible organisms, the possibility of contaminating organisms preventing the possible growth of the meningococcus in the filtrate was excluded. There is thus in these results no evidence that the pathogenic effect was caused by living meningococci.

(3) The average amount of fluid injected in this group was approximately half that employed in Group IA, which latter shows a slightly smaller pathogenic rate.

(4) The long-continued fever obtained in the case of Animals 82 and 80 supports the argument advanced in the case of Animal 79 (Group IA) that this fever was not due to the primary action of a preformed meningococcal toxin.

The results obtained in Animals 80 and 63 (this group) when contrasted with those obtained in Animals 79 and 59 (Group IA) are strongly suggestive. Thus Animals 80 and 79 were injected with the filtered and unfiltered fractions of the same meningococcus-free sample of cerebrospinal fluid which gave rise to pathogenic results tending to correspond fairly enough with the difference in the size of dose employed. But in the case of Animals 63 and 59, where the difference in size of dose was the same as that of the former pair, the pathogenic results obtained were exactly the reverse, inasmuch as the larger dose of the unfiltered sample con-

taining meningococci caused less serious effects than did the meningococcus-free sample injected as filtrate in Animal 63. In order to appreciate this contrast the experimental headings given in each group must be carefully studied.

(5) The true explanation of the great difference, already referred to above, in the results obtained in Animal 53 (of this group) and Animal 52 (Group IA), is difficult, putting aside variations of individual susceptibility. But under any explanation the facts lend additional support to the view that living meningococci are not themselves responsible for the pathogenic results observed. Moreover, as meningococci were not demonstrable in film preparations of the fresh cerebrospinal fluid, although they were shown by suitable methods of cultivation to be present in scant numbers, the pathogenic effect exerted by the filtrate would not appear to be due to the action of a preformed meningococcal toxin derived from the organisms present in such fluid, since filtration and injection were carried out prior to incubation and consequent cultivation of meningococci in the unfiltered fluid. Additional support is given to this hypothesis by the results obtained in Animals 68 and D in Group III, since the inoculum was derived from Case 5, from the cerebrospinal fluid of which, even under intensive cultivation, meningococci were only recovered with difficulty.

GROUP Ic.

INJECTED, AFTER TWENTY-FOUR TO FORTY-EIGHT HOURS' INCUBATION, WITH UNDILUTED, UNFILTERED CEREBROSPINAL FLUID IN WHICH VISIBLE MENINGOCOCCI WERE PRESENT IN LARGE NUMBERS, AND FROM WHICH MENINGOCOCCI WERE CULTIVATED.

Number of animal	Number of case and specimen	Volume of cerebrospinal fluid injected	Route of injection	Period of observation	Result
H 1	L (1)	6·0 c.c.	Peritoneum	63 days	*Nil.*
H 8	B (2)	10·0 ,,	,,	142 ,,	,,
54	7 (2)	10·0 ,,	,,	37 ,,	,,
61	9 (1)	21·0 ,,	Skin	41 ,,	Continued fever.

Total number of animals injected, 4. Fever-rate, 25 per cent; death-rate, *nil*; total pathogenic rate, 25 per cent. Average volume of cerebrospinal fluid injected, 11·7 cubic centimetres.

The points requiring notice in this group are :—

(1) The low pathogenic rate obtained after injection of four animals with large numbers of living meningococci in four different samples of cerebrospinal fluid from four different acute cases. In the case of Animal 8 the inoculum contained 9,200,000,000 organisms.

(2) The average volume of unfiltered cerebrospinal fluid, in this group characterized by low pathogenic rate and by successful cultivation of meningococci, was nearly double the average volume of filtered cerebrospinal fluid injected in the case of the animals in Group IB, no meningococci being cultivated from the filtrates. Nevertheless, the pathogenic rate in Group IB was 85·8 per cent.

(3) In view of the possibility that the results of injection might depend upon the pathogenicity inherent in the particular strain of meningococci, it should be pointed out that under other conditions the same strain used in the case of Animal 54 produced both fever and death in Animal 67 (Group V).

Further evidence against this possibility is given by contrasting the results obtained in Animal 52 and Animal 53 (Group IA and B), and by a consideration of all those instances in which pathogenic effect was produced by the injection of meningococcus-free inocula.

GROUP ID.

INJECTED WITH FILTERED CEREBROSPINAL FLUID, MENINGOCOCCI BEING SUBSEQUENTLY CULTIVATED FROM FILTRATE.

Number of animal	Number of case	Volume of cerebrospinal fluid injected	Route of injection	Period of observation	Result
H 12	N 1	3·5 c.c.	Peritoneum	23 days	*Nil.*
H 9	N 1	1·5 ,,	,,	23 ,,	,,
H 11	B 2	4·0 ,,	,,	39 ,,	,,
H 15	B 2	3·5 ,,	,,	19 ,,	,,
H 10	B 1	3·5 ,,	,,	149 ,,	,,
H 14	B 1	1·0 ,,	,,	56 ,,	Continued fever.

Total number of animals injected, 6. Fever-rate, 16·7 per cent; death-rate, *nil;* total pathogenic rate, 16·7 per cent. Average volume of cerebrospinal fluid injected, 2·83 cubic centimetres.

Note.—Animal 11 and Animal 14 were injected with unincubated filtrates from fresh cerebrospinal fluid, the remaining animals in this group being injected with incubated filtrates from incubated cerebrospinal fluid.

In the case of Animals 11 and 15 Berkefeld filters were employed, Chamberland F filters being employed in the case of the remaining animals in this group.

In this group the following points deserve notice :—

(1) Successful cultivation of meningococci from filtrates of cerebrospinal fluid, the filters employed being Berkefelds and Chamberlands F.

(2) The low pathogenic rate obtained after injection of living cultures of meningococci in these filtrates of cerebrospinal fluid recalls the absence of effect after injection of unfiltered cerebro-

spinal fluid from which meningococci were cultivated into Animals 52, 1, 8 and 54 in Groups IA and IC, and contrasts strongly with the positive results obtained in Group IB, the filtrates in the latter group producing a high pathogenic rate, yet giving no cultures of meningococci.*

(3) The only animal in which a demonstrable reaction occurred was that which received the smallest inoculum.

(4) Animal 10, injected with a larger inoculum of the same filtrate, after incubation for twenty-four hours, showed no reaction.

(5) The average volume of inoculum in this group—characterized by cultivation of meningococci from the filtrates, and by the lowest pathogenic rate so far recorded—is little less than the average volume of the inoculum in Group IB, in which the opposite conditions obtain.

(6) It is possible that the disparity between the results obtained in Groups IB and ID is due to the fact that in Group ID the majority of the animals were injected with cerebrospinal fluid which had been incubated before and after filtration, whilst in Group IB the majority were injected with cerebrospinal fluid not submitted to incubation either before or after filtration.

(7) This explanation is to some extent supported by the facts that—(*a*) In Group IB, injection of Animal 55 with six cubic centimetres of filtered fluid, which was not submitted to incubation either before or after filtration, produced death in five days, whilst injection of Animal 57, although with a smaller volume of the same filtrate after incubation for twenty-four hours, produced no obvious effect during the period of observation of thirty-nine days. (*b*) In Group ID, injection of Animal 14 with one cubic centimetre of filtered fluid, not incubated either before or after filtration, produced a continued fever lasting for sixty-five days, whilst injection of Animal 10 in the same group with 3·5 cubic centimetres of the same filtrate after incubation for twenty-four hours produced no obvious effect in a discontinuous period of observation of 149 days.

It is evident that this loss of pathogenicity effected by incubation of an infected body fluid may be due to death of the pathogenic agent, to insusceptibility of the particular animal, or to loss of pathogenic activity not necessarily dependent on destruction.

An apparent exception to the loss of pathogenicity effected by incubation is afforded by Animal 63, Group IB, which was injected with filtered cerebrospinal fluid incubated for forty-eight hours after filtration.

The conditions of the two experiments are not, however, strictly

parallel, since the cerebrospinal fluid injected into Animal 63 was not incubated before filtration. Moreover, the incubated filtrate was meningococcus-free.

The following classification of the results obtained in these four groups of animals shows:—

(1) That either continued fever or death, or both, followed in each case the injection of eight animals with specimens of fresh cerebrospinal fluid (including filtered and unfiltered) from which no meningococci could be cultivated, a total pathogenic rate of 100 per cent (vide Animals 43, 79, 55, 53, 63, 58, 80 and 82).

(2) That of thirteen animals injected with fresh or incubated cerebrospinal fluid (including filtered and unfiltered) from which meningococci were cultivated no reaction was observed in nine, a total pathogenic effect of 30·8 per cent.

(3) The presence of a pathogenic filter-passing agent of unknown nature in the cerebrospinal fluid of acute cases of the disease.

GROUP II.

INJECTED WITH HUMAN CEREBROSPINAL FLUID, INCUBATED FOR SEVERAL WEEKS, FROM WHICH NO MENINGOCOCCI COULD BE CULTIVATED AT THE TIME OF INJECTION, THOUGH THEY WERE CULTIVATED FROM THE FRESH FLUID.

A. *Unfiltered.*

Number of animal	Number of case and specimen	Volume of cerebrospinal fluid injected	Route of injection	Period of incubation	Period of observation	Result
50	9 (1)	2·50 c.c.	Peritoneum	6 weeks	4 days	Death.
47	8 (1)	2·50 ,,	,,	7 ,,	33 ,,	Fever and death.
46	8 (1)	0·75 ,,	,,	7 ,,	30 ,,	*Nil.*

Total number of animals injected, 3. Fever-rate 33 per cent; death-rate, 66 per cent; total pathogenic rate, 66 per cent. Average volume of cerebrospinal fluid injected, 1·9 cubic centimetre.

B. *Filtered.*

Number of animal	Number of case and specimen	Volume of cerebrospinal fluid injected	Route of injection	Period of incubation	Period of observation	Result
42	8 (1)	0·5 c.c.	Peritoneum	7 weeks	7 days	Death.
84	7 (1)	1·0 ,,	,,	5 ,,	33 ,,	Continued fever.

Fever-rate, 50 per cent; death-rate, 50 per cent; total pathogenic rate, 100 per cent. Average volume of cerebrospinal fluid injected, 0·75 cubic centimetre.

The filters employed were new Chamberland F bougies.

The experiments next to be described were undertaken in order to determine if this filter-passing agent of unknown nature can survive in the laboratory, and if it is capable of cultivation.

For the sake of brevity it will now be convenient to refer to this filter-passing agent as X.

In this group the two chief points to which attention is directed are:—

(1) The survival of the pathogenicity of X after several weeks, as shown both in the filtered and in the unfiltered fluids.

(2) In the case of Animal 42, in which a fatal result followed injection, in the case of Animal 47, in which fever and death followed injection, and in the case of Animal 46, in which injection produced no apparent effect, the inocula were all derived from the same patient.

GROUP III.

Injected with Cultures of X, in Serum-broth, from Human Cerebrospinal Fluid, from the Cerebrospinal Fluid of Monkeys injected Intraperitoneally with Human Cerebrospinal Fluid and from the Cerebrospinal Fluid of a Third-passage Monkey, no Visible Organisms having been Cultivated from the Cultures of X Injected.

Number of animal	Number of case and specimen	Source of culture	Size of dose injected	Route of injection	Age of culture	Period of observation	Result
75	8 (2)	Human	10 c.c.	Peritoneum	17 days	44 days	Continued fever.
68	5 (1)and(2)	Monkeys 53 and 60	8·5 ,,	,,	5 ,,	16 ,,	Fever and death.
D	5 (1)and(2)	Monkey 68	5 ,,	,,	18 hours	68 ,,	Fever and death.
3	10 (2)	Monkey 79	26 ,,	,,	7 days	34 ,,	*Nil.*
4	8 (2)	Monkey 75	21 ,,	,,	13 ,,	34 ,,	,,
1	10 (2)	Human	18 ,,	,,	9 days' culture from 15 days' filtrate	14 ,,	Death.
2	7 (2)	,,	18 ,,	,,	5 days' culture from 42 days' filtrate	34 ,,	Continued fever.

Total number of animals injected, 7. Fever-rate, 57·2 per cent; death-rate, 42·8 per cent; total pathogenic rate, 71·6 per cent.

Before presenting the conclusions to be drawn from the results recorded in this group it may be well briefly to refer to certain cultural phenomena which indirectly led to the attempt to obtain X in pure culture and subculture.

It had previously been noted by Hort that inoculation of ascitic fluid or of serum-broth with cerebrospinal fluid or with saline emulsions of the lysed deposit of the blood from acute cases of cerebrospinal fever sometimes produced after incubation a diffuse turbidity which could not be entirely cleared by prolonged centrifuging. And the same phenomenon was also noted by him in the case of ascitic fluid or serum-broth inoculated with typhus blood, scarlet fever blood, or with saline emulsions from throat swabs in the early stages of scarlet fever and cerebrospinal fever, as well as in filtrates from all these sources after enrichment with ascitic fluid or serum-broth. In some of these filtrates the presence of visible organisms could not be demonstrated by cultural methods, nor in some of the unfiltered fluids after prolonged centrifuging. The infectivity of the latter fluids in the case of scarlet fever was, however, demonstrated by subcutaneous injection of monkeys.

During the course of the present work an endeavour was made to make a closer study of these cultural phenomena. It was noticed, for example, by Caulfeild that in many instances growth of the meningococcus in serum-broth was accompanied by the production of a dry, floating pellicle, from which meningococci could be subcultured even though controls made from other parts of the culture (or from control solid media) had failed to show growth. General turbidity was also obtained on many occasions by subculture from solid media of meningococcal colonies, isolated from cerebrospinal fluid and from colonies of organisms other than the meningococcus obtained from the same source. In some cases the turbidity produced in the fluid cultures of visible organisms was found by Caulfeild to present not a diffuse but a superficial turbidity, confined to the upper layers as a suspended haze, this clouding (dense or faint) of the upper layers being clearly cut off from the lower unclouded layers.

Shortly after these cultural characteristics had been observed and appreciated, a turbidity very similar to that described in connexion with active growth of the meningococcus was noticed in certain of the serum-broth cultures of the cerebrospinal fluid from Case 8 (2), with the important difference, however, that no growth of visible organisms could be obtained on the solid media inoculated at the same time, as well as subsequently, from the turbid serum-broth culture itself. This particular parent serum-broth culture had received about 0·25 cubic centimetre of cerebrospinal fluid. Three days later about 0·25 cubic centimetre of this culture was used for the daughter serum-broth culture, which after

about ten days showed a distinct suspended haze and from which again no growth or visible organisms could be cultivated. Both cultures were inoculated into Monkey 75, and were followed by continued fever.

These three animals (75, 1 and 2) injected with cultures and subcultures (free from visible organisms) from human cerebrospinal fluid (filtered and unfiltered) show nevertheless a pathogenic rate of 100 per cent and a death-rate of 33·3 per cent.

In this group four animals were injected with cultures of X from the cerebrospinal fluid of monkeys, in contrast to the human source of the inocula given in the preceding three animals. The theoretical objection might be raised that the continued fever exhibited by Animal 75 was due to the action of a pyrogenetic toxin contained in the small quantity (0·25 cubic centimetre) of cerebrospinal fluid present in the cultures injected rather than to the action of an invisible virus, the amount of which had been increased by cultivation. This latter explanation is, however, strongly supported by the results obtained in the case of Animals 1 and 2, the inocula for these animals being serum-broth cultures from filtered human cerebrospinal fluid which, after filtration, had been standing for a considerable time at 37° C. Moreover, the volume of cerebrospinal fluid carried over in all the subcultures injected cannot have exceeded 0·01 cubic centimetre in the case of Animal 2, and little more than this in the case of Animal 1.

Monkey 68 died with fever after inoculation with 8·5 cubic centimetres serum-broth parent cultures of the cerebrospinal fluid of Monkeys 53 and 60, the former of which died following injection of filtered human cerebrospinal fluid filtrate from Case 5 (1), the latter dying after injection of cultures from both samples of Case 5, the amount of cerebrospinal fluid from the two monkeys implanted in the serum-broth injected being under 0·5 cubic centimetre.

Injection of Monkey D with five cubic centimetres serum-broth parent culture of the cerebrospinal fluid of the preceding animal (68) was followed by continued fever and death, a successful third-passage result (or a second passage of X in pure culture) being thus afforded. The amount of cerebrospinal fluid contained in the serum-broth was less than 0·35 cubic centimetre.

The only two monkeys (3 and 4) in the group failing to show pathogenic results in terms of fever or death received respectively cultures made from the cerebrospinal fluid of an *unfiltered* human

cerebrospinal fluid, Monkey 75 showing fever only after the injection of a single culture of X, obtained, from unfiltered human cerebrospinal fluid. It is worth note that the source of the inoculum in both these negative cases was from unfiltered cerebrospinal fluid.

That the fever and death occurring in the case of the second- and third-passage monkeys (68 and D) was the result of the tuberculous disease found after death in Monkey 60, supplying the cerebrospinal fluid injected, is ruled out by the absence of any post-mortem evidence of tuberculosis in these two animals.

In all the cultures used for inoculation in this group, the culture controls showed no growth of visible organisms. Moreover, all the cultures showed a turbidity, superficial or diffuse. In the latter case it is possible that the superficial turbidity seen in the early stages of cultivation had been overlooked.

As already stated, we do not at present know if this turbidity is directly caused by aggregations of the invisible virus X or if the degree of turbidity only indirectly corresponds with the concentration of X; but it was this gross evidence which led to the choice of cultures of X for injection. Relying upon this evidence, subcultures have been carried to the fifth and sixth generation from unfiltered and from filtered human cerebrospinal fluid, from the cerebrospinal fluid of monkeys successfully inoculated with human cerebrospinal fluid, and from the cerebrospinal fluid of passage monkeys. The pathogenicity of late cultures was not tested because of the shortage of animals, and further cultivation was not attempted.

Control tubes of serum-broth and of serum-agar were incubated on each occasion of cultivation and of subcultivation of the cultures of X.

Out of seven, or more, batches of horse serum used during the work, five proved to be sterile both as regards the development of visible and invisible organisms. In the two defaulting sera a clearly defined surface turbidity, indistinguishable from that already described, developed after incubation. This result shows that in using serum for cultural purposes it is essential to be certain that filtrable viruses are not present by the application of inoculation, as well as of cultural tests.

This elaboration of the data recorded in this group justifies, in our view, the following conclusions:—

(1) The filter-passing agent X is apparently capable of cultivation and of subcultivation in serum-broth.

(2) X can be obtained from the cerebrospinal fluid of monkeys injected with human cerebrospinal fluid containing X.

(3) X obtained from the cerebrospinal fluid of monkeys is capable of passage through further monkeys, and of recovery therefrom.

(4) These observations, when taken in conjunction with the fact that no visible organisms could be cultivated from the cultures of X injected, strongly suggest that X is a living virus capable of self-propagation.

GROUP IV.

CULTURAL RESULTS OF BACTERIOLOGICAL EXAMINATION OF THE BLOOD AND CEREBROSPINAL FLUID OF INJECTED MONKEYS.

Number of animal supplying material for examination	Number of case supplying material for injection of animal	Visible organisms cultivated from— Cerebrospinal fluid	Visible organisms cultivated from— Blood	Fate of animal injected	Gross post-mortem changes
53 (giving X)	5 (1)	*Nil*	*Nil*	Death	*Nil.*
43	6 (2)	Streptococci	Streptococci	,,	,,
73 (giving X)	8 (2)	*Nil*	Not examined	Fever	Still living.
68 (giving X) passage	5 (1)and (2)	,,	*Nil*	Fever and death	*v.* below.
55	6 (1)	Visible organisms	Not examined	,, ,,	*Nil.*
60	5 (2)	*Nil*	*Nil*	,, ,,	*v.* below.
79 (giving X)	10 (2)	,,	,,	,, ,,	*Nil.*
66	5 (2)	,,	Not examined	,, ,,	*v.* below.
88	8 (2)	,,	,, ,,	,, ,,	,,
62	6 (1)	,,	*Nil*	,, ,,	*Nil.*
76	8 (1)	,,	Not examined	,, ,,	Slight general œdema.
1 (giving X)	10 (1)	,,	*Nil*	Death	*Nil.*
63 ,,	8 (2)	,,	Not examined	Fever and death	,,
67	7 (1)and (2)	,,	,, ,,	,, ,,	,,
D passage ..	5 (1)and (2)	Not done	*v.* below	,, ,,	,,

Note.—Animals 60, 66 and 88 were found after death to be infected with tuberculosis, 60 suffering from generalized disease, 66 and 88 showing tuberculous nodules in the spleen.

Further details regarding this group are:—

(1) Puncture of the spinal canal was performed at the post-mortem examination as well as during life, when it was in no instance followed by any ill-effects.

(2) Investigation of the cerebrospinal fluid of Monkey 60 revealed, fourteen days after inoculation, a turbidity without growth of visible organisms. Thirty-four days after inoculation both streptococci and staphylococci were demonstrated to be present,

while at the post-mortem puncture no growth of visible organisms was obtained.

(3) The notes in the table (Group IV) regarding the recovery of X indicate that the serum-broth tubes showed turbidity, either general or localized, as a suspended haze, as well as the absence of growth of visible organisms. In certain instances it was difficult to be certain whether turbidity was or was not present.

(4) In the eight bacteriological investigations of the heart's blood which were made, growth of visible organisms could only be obtained in two cases. In Monkey 43 the same organism was found to be present in the blood and in the cerebrospinal fluid. In the case of Monkey D, found dead at 7 a.m., the cultures made at 5 p.m. on the same day gave results suggesting intestinal infection occurring after death. As culture media, both serum-broth and serum-agar were used, and in a number of the investigations the blood was citrated, centrifuged, and the corpuscles lysed before inoculation of these media.

(5) The post-mortem examination included an inspection of the meninges, which in no instance showed gross pathological changes, even in the case of animals injected with living meningococci.

NATURE OF MATERIAL INJECTED INTO ANIMALS (GROUP IV) SUPPLYING CEREBROSPINAL FLUID AND BLOOD FOR BACTERIOLOGICAL EXAMINATION.

Animal 53: 4·5 cubic centimetres filtered human cerebrospinal fluid from which no meningococci could be cultivated.

Animal 43: twelve cubic centimetres unfiltered human cerebrospinal fluid from which no meningococci could be cultivated.

Animal 73: culture of X from unfiltered human cerebrospinal fluid in serum-broth in which no meningococci could be cultivated.

Animal 68: 8·5 cubic centimetres serum-broth cultures of X from the cerebrospinal fluid of Monkeys 53 and 60, injected respectively with filtrate of human cerebrospinal fluid from Case 5 (1), and with meningococcal culture of Case 5 (2).

Animal 60: ten cubic centimetres serum-broth culture of meningococci from human cerebrospinal fluid of Case 5 (2).

Animal 79: fifteen cubic centimetres unfiltered human cerebrospinal fluid Case 10 (2), consisting of the supernatant fluid and the lysed (with distilled water) deposit. No meningococci were cultivated from the cerebrospinal fluid, although gross evidence of X was suggested by the presence of superficial turbidity.

Animal 66: fifteen cubic centimetres of a fifty per cent suspension in solution of 1·2 per cent sodium citrate of heart blood obtained from Monkey 60 by cardio-puncture.

Animal 88: pure culture of diphtheroid bacillus obtained in a late serum-broth culture from Case 8 (2), which showed the suspended haze condition.

Animal 62: 5·5 cubic centimetres serum-broth culture of meningobacillus from cerebrospinal fluid of Monkey 55, injected with filtered human cerebrospinal fluid from Case 6 (1), no meningococci being cultivated from filtrate.

Animal 76: six cubic centimetres serum-broth culture of meningococci isolated from human cerebrospinal fluid of Case 8 (1).

Animal 1: subculture in serum-broth of X from human filtered cerebrospinal fluid of Case 10 (2). No meningococci could be cultivated from culture of X, or from the unfiltered human cerebrospinal fluid, or from the filtered cerebrospinal fluid supplying culture of X.

Animal 63: ten cubic centimetres filtered human cerebrospinal fluid from Case 8 (2). No meningococci could be cultivated from the filtered or unfiltered cerebrospinal fluid (human).

Animal 67: four serum-agar cultures of meningococci from human cerebrospinal fluid of Case 7 (1) and (2).

Animal D: five cubic centimetres pure culture in serum-broth of X, from cerebrospinal fluid of Monkey 68, inoculated with serum-broth culture of X from cerebrospinal fluid of Monkeys 53 and 60. No visible organisms could be cultivated from any of the cultures of X involved in passage.

The points requiring note in Group V are :—

(1) Post-mortem examination of Animals 57, 76, 67, and 60 injected with cultures of meningococci in serum-broth or on serum-agar revealed no involvement of meninges apparent to the naked eye. No visible organisms could be cultivated from the cerebrospinal fluid of these animals during or after life, and no cultivation of X was made in any of these cases. The blood of Animals 57, 76, and 67 was not examined. Animals 57 and 60 showed extensive tuberculous disease when examined after death.

(2) The pathogenicity of cultures of meningococci in the case of Animals 92 and 80 appears to have been unimpaired by growth on ordinary peptone-agar containing no serum.

(3) Injection into Animal 91 of the filtrate (Chamberland F) of the same culture on peptone-agar which produced continued fever when injected unfiltered into Animal 92, was followed in nineteen days by death of the former animal.

(4) Injection into Animal 93 of the filtrate (white Doulton bougie) of the same culture on peptone-agar which produced fever when injected unfiltered into Animals 94 and 80 was followed by continued fever in the animal receiving the filtrate.

GROUP V.

INJECTED WITH SUBCULTURES ON AGAR, OR ON SERUM-AGAR OR IN SERUM-BROTH, OF MENINGOCOCCI ISOLATED FROM THE CEREBROSPINAL FLUID OF ACUTE HUMAN CASES.

A. *Unfiltered.*

Number of animal	Number of case and specimen	Nature of medium	Dose	Route of injection	Period of observation	Result
76	8 (1)	Serum-broth	6·0 c.c.	Peritoneum	36 days	Continued fever and death.
67	7(1) and (2)	Serum-agar	Four slopes	,,	29 ,,	Continued fever and death.
92	15 (1)	Agar	Half slope	,,	21 ,,	Continued fever.
94	14 (1)	,,	,,	,,	20 ,,	Fever and collapse.
80	14 (1)	,,	,,	,,	21 ,,	Continued fever.
60	5 (2)	Serum-broth	10·0 c.c.	Skin	—	Continued fever and death.
57	10 (1)	Serum-broth	Two slopes	Peritoneum	48 ,,	Continued fever and death.

Total number of animals injected, 7. Fever-rate, 100 per cent: death-rate, 57·2 per cent; total pathogenic rate, 100 per cent.

Note.—Animals 92, 94, and 80 exhibited when killed extensive tuberculosis.

B. *Filtered.*

Number of animal	Number of case and specimen	Nature of medium	Filter employed	Organisms cultivated from filter	Route of injection	Period of observation	Result
91	15 (1)	Agar	Chamberland F	*Nil*	Peritoneum	19 days	Death.
93	14 (1)	,,	Doulton	,,	,,	21 ,,	Continued fever.

Note.—Animals 91 and 93 exhibited no tuberculous lesions *post mortem.*

In view of these results it appears that X is capable of cultivation on solid media for a time, or at least of survival thereon, and that it is capable of passage through a white Doulton filter as well as through the coarser Chamberland F filters. Hence X may be partly or wholly responsible for the pathogenic effects obtained in the case of Animals 76, 67, 92, 94, 80 and 60 injected with cultures of meningococci, injection of the filtered emulsions in the only two

cases tested being followed by the same pathogenic effects as the unfiltered emulsions in both. Further experiments dealing with filtered cultures are now being carried on.

Discussion.

In discussing the issues raised by the experimental results here recorded it is necessary to keep in mind the following facts which the experiments appear to have established :—

(1) The cerebrospinal fluid of acute human cases of the disease often contains a filter-passing virus which, whatever its nature, is not the meningococcus as such.

(2) When injected into monkeys by the peritoneal or subcutaneous route the demonstrable pathogenic effects following injection of filtered or unfiltered cerebrospinal fluid, of X in pure culture, and of cultures of the meningococcus always included continued fever or death.

(3) In no case did injection of any of the inocula mentioned produce *the* cardinal feature of the disease as it occurs in man—viz., demonstrable involvement of the cerebrospinal system.

With these facts in view it is difficult to resist the conclusion that the apparent pathogenicity of the meningococcus when injected viâ the skin or peritoneum is due to the hitherto unsuspected presence of X, which must therefore be taken into account, as we shall now show, when the results obtained by Flexner after intraspinal injection are considered.

The various meningococcal emulsions used by Flexner were, as already stated, introduced into the spinal canal of monkeys, injection being frequently followed by collapse and death within a very few hours (twelve to twenty). In addition to the local pathological tissue changes found after death it is to be noted that recovery of the meningococcus even so short a time after inoculation was by no means invariable. In those cases in which death took place later than twenty hours the meningococcus was only isolated in one instance. In this animal (Monkey 18) positive growths were obtained in some of the cultures sixty hours after the inoculation, although a sample of cerebrospinal fluid obtained during the first twenty-four hours did not yield the meningococcus. In this connexion Flexner admits that the "amount of multiplication of the diplococcus in monkeys, excepting possibly in the focal abscesses, is, under the most favourable circumstances, small." He expresses himself, in fact, as "disinclined to believe that in many of the experiments any multiplication whatever took place." He

also says: "As compared with the doses which probably determine infection in man, those used to produce the experimental disease in monkeys are colossal." The mere fact of the injections being given by the meningeal route excludes his results as proof of direct etiological relationship of the meningococcus to the disease on account of the readiness with which meningitis can be produced in monkeys by intraspinal injection of other organisms. Another point brought out by Flexner which is highly significant in the light of our results was that after apparent recovery some of his animals died suddenly from causes unexplained by post-mortem examination. Moreover, as our experiments show, there is not sufficient evidence that the pathogenicity of Flexner's inocula was due to the action of the meningococcus as such, because this organism was the only pathogenic agent he recognized in, or attempted to isolate from, the emulsions injected, and, as already noted, recovery of the meningococcus was inconstant, even when death occurred a few hours after injection. To sum up, therefore, in the absence of better evidence than that adduced by Flexner in favour of the meningococcus as the direct cause of the disease, his results strongly suggest either that death was due to the action of meningococcal toxin present in the colossal doses of culture he employed or to the unsuspected presence of the agent we have referred to as X.

It is now necessary briefly to discuss the probable nature of X as shown by our own experiments.

At first sight it would appear that X acts as a preformed toxin, and is itself, in fact, a toxin. In so far as the production of continued fever is concerned, this explanation cannot be accepted, because, as we have already pointed out, there is no known toxin a single injection of which is directly capable of producing continued fever in healthy man or in healthy animals. The fever produced in healthy subjects by single injections of a preformed toxin is practically immediate and is always fugitive, as was shown by Hort and Penfold [8] in the case of the commoner Gram-negative organisms. In no case were these observers able to produce continued fever in healthy animals by a single injection of preformed toxin, and they also showed that injection of albumoses, or other degradation products, does not produce fever, and that disturbances of colloidal equilibrium giving rise to continued fever is a theory which can only be invoked in the case of living protista. On the other hand, they also found that they were unable to produce continued fever in animals, comparable with that which

occurs in disease, unless the organisms injected produced demonstrable disease, and in all cases there was an appreciable latent period, strongly contrasting with the absence of the latent period after injection of preformed pyrogen. The continued fever noted, therefore, in the animals injected, in which a definite latent period of twenty-four to forty-eight hours was the rule, cannot reasonably be explained by the assumption that X is a preformed toxin.

It is, however, theoretically possible to produce continued fever in animals affected, for example, by latent tuberculosis by the injection of a toxin itself unable directly to produce continued fever. In such case there is, perhaps, a mobilization of fever-producing organisms induced by the action of a resistance-depressing toxin, such action being only secondary in nature. The continued fever thus produced must be sharply distinguished from the immediate fugitive fever induced in healthy subjects by the injection of a preformed pyrogen, the resultant fever being a purely primary effect. A good example of the secondary effect of a toxic substance, itself incapable of directly producing continued fever, is the following: A monkey which appeared to be healthy, observation for several weeks revealing no rise of temperature above the normal range, was injected intraperitoneally with two slopes of a serum-agar living culture of meningococcus from an acute human case of cerebrospinal fever. For eighteen days after injection no disturbance of the internal body temperature showed itself, observations being taken twice daily. On the nineteenth day an acute fever set in which lasted till the animal's death a few weeks later. Post-mortem examination revealed very extensive acute tuberculosis of the lungs and pleura, with deposits in the spleen and liver. Control injections of non-tuberculous monkeys with serum-agar cultures of meningococci from acute human cases of cerebrospinal fever showed that the continued fever which may follow injection begins within a day or two of injection, provided that the reaction is not masked by too massive a dose. Hence it is clearly a matter of importance in attempting to determine the nature of X to be certain that only healthy animals are injected therewith. Suspicion, however, would be raised that unsuspected disease existed in the animal under observation if continued fever, as in the case noted, only made its appearance after an unusually long latent period.

In the cases in which death occurred not preceded by continued fever it is theoretically possible that the action of a preformed toxin was responsible. But as these results were obtained by the same type of inoculum causing continued fever, not directly due to

the action of preformed toxin, it does not seem illogical to conclude that death without fever may also not have been due to preformed toxin. This argument applies more particularly to those cases in which a fall of temperature followed injection with recovery to the normal before death, such fall being as significant of the action of a toxin as a rise, whether the toxin be preformed or the result of a genuine infection in the host.

The primary action, therefore, of a preformed toxin in the production of death or of continued fever appears to be discounted, if not entirely excluded.

It is, however, conceivable that the injection of an inanimate toxin might secondarily give rise to continued fever by so depressing the resistance of an animal to infection that parasitic organisms might invade it, or that, quite apart from pre-existing disease, saprophytic organisms already present might take on a parasitic phase, and thus produce a systemic infection. To avoid such source of fallacy, in attempting to interpret the sequence of events after injection of a filtrate, or of cultures therefrom, even when containing no visible organisms capable of cultivation in the laboratory, it is, of course, necessary to submit to searching cultural observations the body fluids of the animal receiving the injection in the event of continued fever or death resulting. If in such case no visible organisms can be cultivated from the body fluids it can reasonably be assumed, provided that reliance is not exclusively placed on the results following inoculation of solid media with the unincubated body fluids, that the continued fever at least is the result of the pathogenic action of a living virus, introduced from without, and is not the result, direct or indirect, of the action of a preformed toxin.

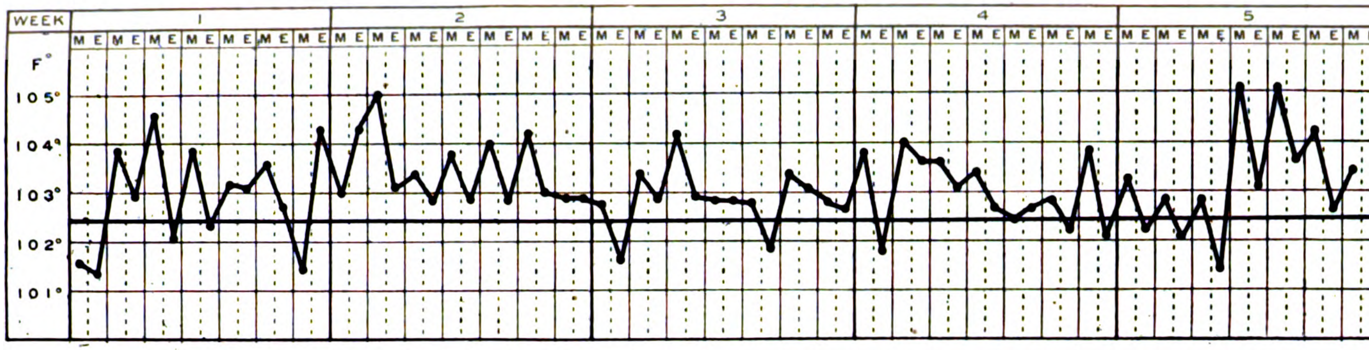
As will be seen by reference to the bacteriological data given in Group IV of this communication this test was successfully passed in the case of several animals injected with X, animals in which pronounced pathogenic effects were observed. We feel justified, therefore, in concluding that the filter-passing agent under discussion is a living virus, and that it was directly responsible for the pathogenic results obtained irrespective of the type of inoculum. Heat tests in this connexion are, of course, practically worthless.

Additional evidence that X is a living virus capable of propagation is afforded by the successful passage experiments cited.

This deduction is, of course, based on the assumption that the conventional criterion of the presence of an invisible living virus is soundly based.

Cerebrospinal Series 10b. MONKEY 80. Intraperitoneal.

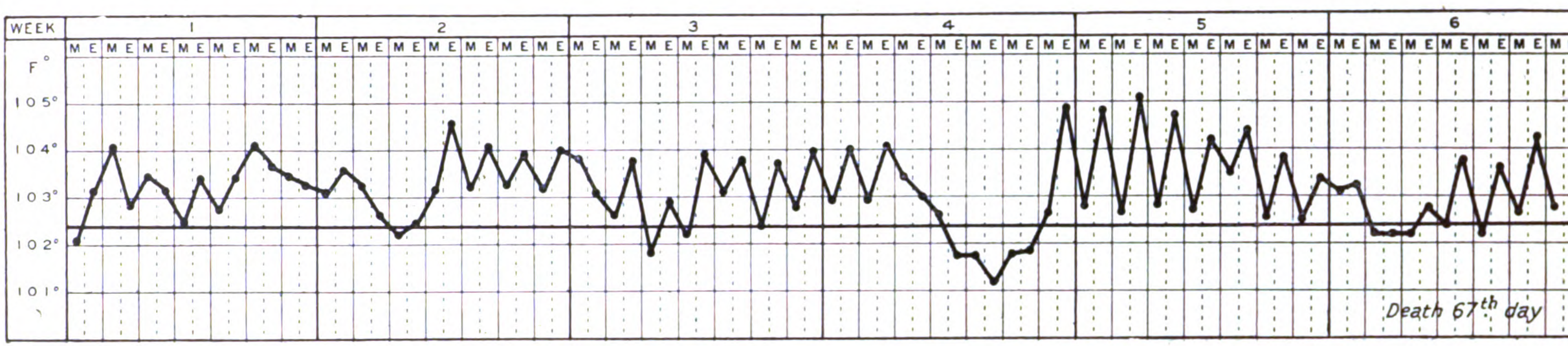
Filtered C.S. Fluid (13·0 c.c.).



No meningococci could be cultivated from unfiltered fluid.

Cerebrospinal Series 8b. MONKEY 63 (CASE 8). 16·0 c.c. Intraperitoneal.

(Filtrate Chamberland F.) Incubated two nights.



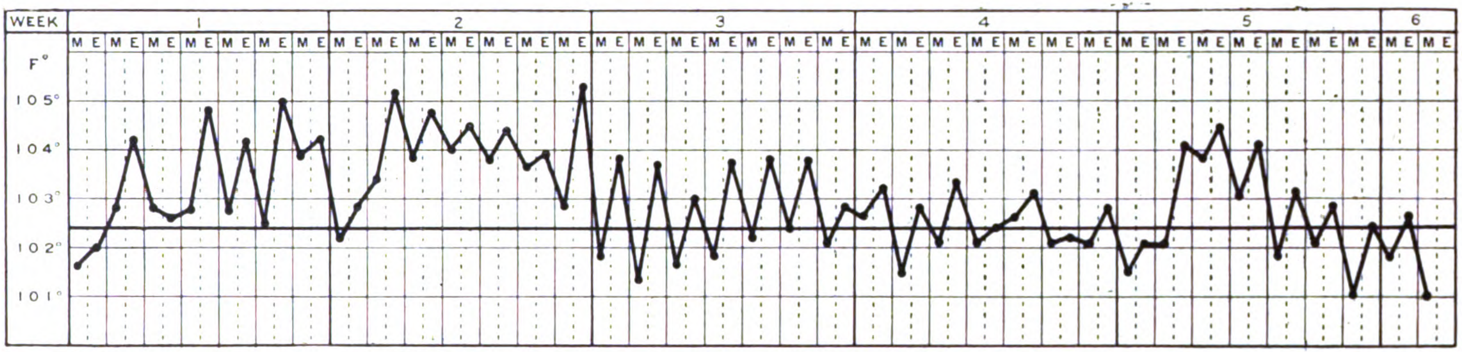
No meningococci could be cultivated from unfiltered fluid.

Cerebrospinal Series 8b

MONKEY 75.

Intraperitoneal.

Serum-broth culture X; no visible organisms grown.

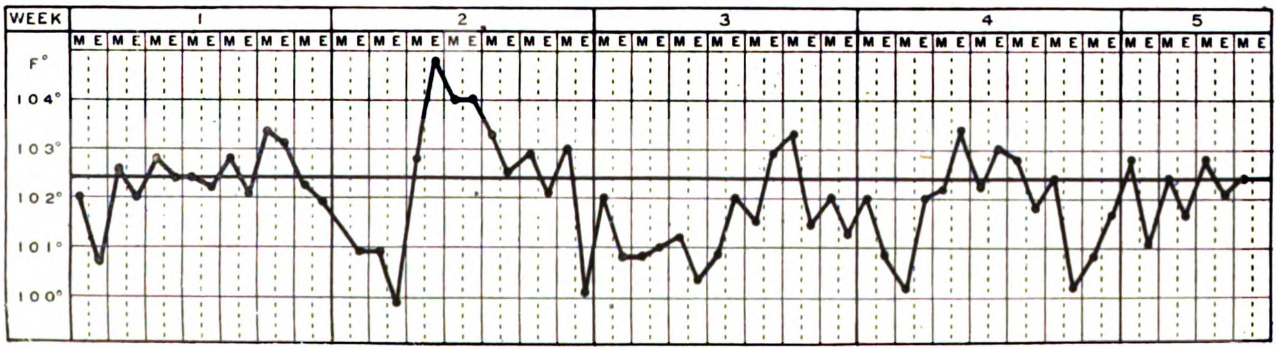


Cerebrospinal Series.

MONKEY 2.

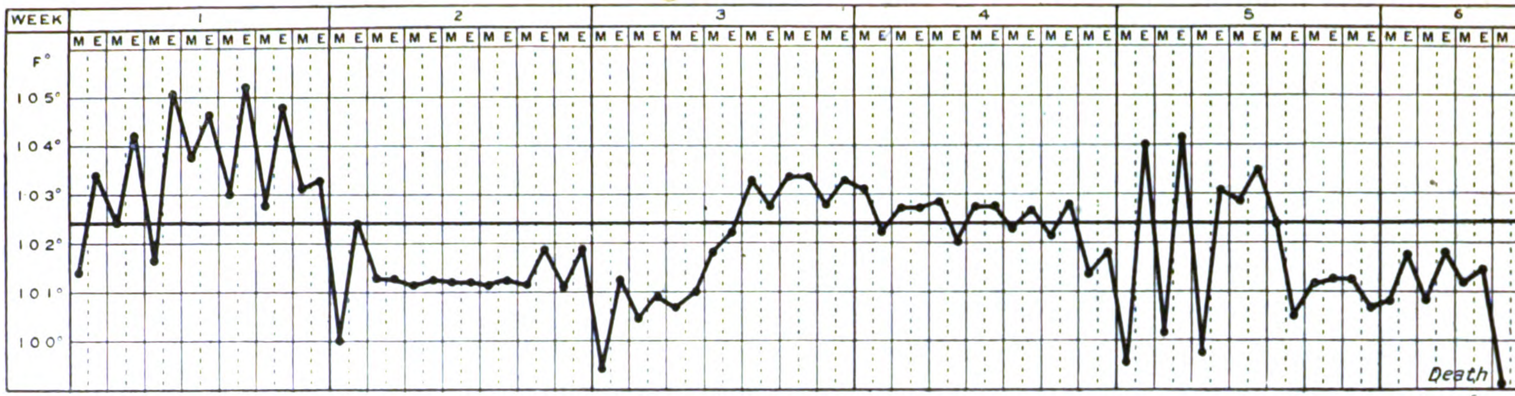
Intraperitoneal.

Serum-broth culture X; no visible organisms grown.



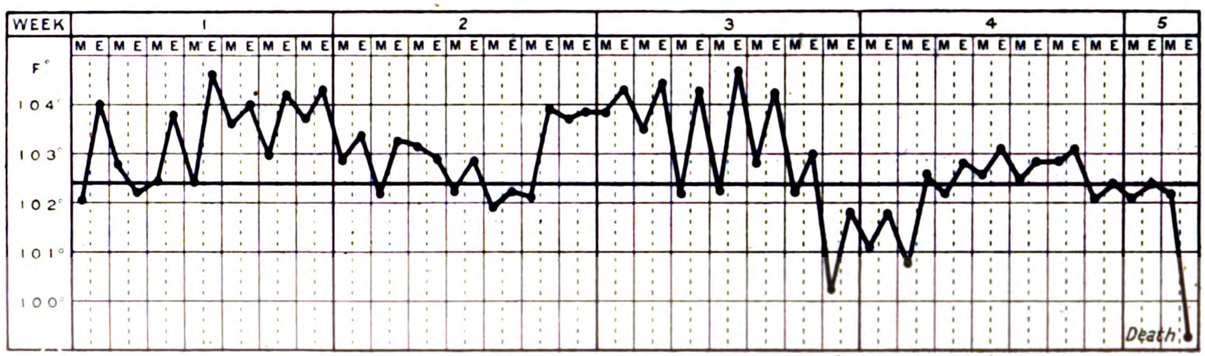
CEREBROSPINAL SERIES 8A. MONKEY 76. INTRAPERITONEAL.

Meningococcus culture (early culture in serum-broth) (6·0 c.c.).



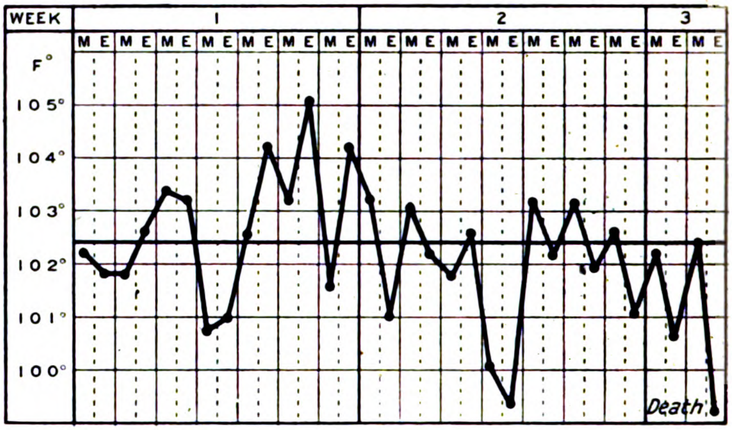
CEREBROSPINAL SERIES 7A AND B. MONKEY 67. INTRAPERITONEAL.

Meningococcus culture (serum-agar) four slopes.



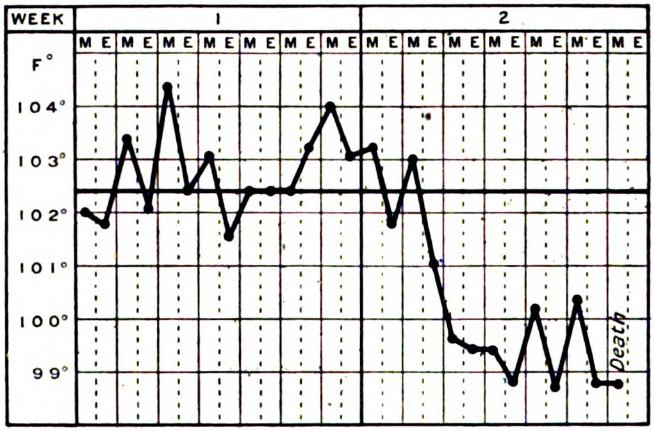
CEREBROSPINAL SERIES. MONKEY 68. INTRAPERITONEAL.

Serum-broth culture of X from monkey cerebrospinal fluid.



MONKEY 79 (CASE 102).

Unfiltered cerebrospinal fluid.



No meningococci could be grown from fluid.

CHARTS.

It is not possible to reproduce all the temperature charts of the large number of animals injected.

The foregoing are therefore selected in order to illustrate the points referred to in the text as regards the injection of—

(1) Cultures of meningococci (76, 67).
(2) Cultures of the filter-passing virus X (68, 75, 2).
(3) Filtered cerebrospinal fluid (80, 63).
(4) Unfiltered cerebrospinal fluid containing no meningococci (79).

Conclusions

(*Based on Intraperitoneal and Subcutaneous Injection*).

(1) The pathogenicity to monkeys of cerebrospinal fluid from acute cases of cerebrospinal fever appears to tend to vary inversely as its meningococcal content.

(2) The cerebrospinal fluid in this disease sometimes contains a filter-passing agent which is not the meningococcus, but which is nevertheless capable of producing in monkeys continued fever or death.

(3) This filter-passing agent appears to be a living virus capable of cultivation in the laboratory and of passage through monkeys.

(4) None of the pathogenic results here recorded can be reasonably attributed to the action of living meningococci as such, or to the direct or indirect action of a meningococcal toxin.

(5) The pathogenicity of cultures of the meningococcus appears to be due to the concomitant presence of the filter-passing virus described.

(6) The pathogenic effects observed in the monkeys injected, whether with cultures of meningococci, with filtered or unfiltered cerebrospinal fluid, or with cultures of X, did not include gross pathological changes in the cerebrospinal system.

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[1] Flexner. *Journ. of Exper. Med.*, 1909, pp. 142 *et seq.*

[2] Hort, Lakin and Benians. *Brit. Med. Journ.*, March 27, 1915, and November, 1915.

[3] Idem. *Loc. cit.* [2].

[4] Idem. Journal of the Royal Army Medical Corps, February, 1916.

[5] *Loc. cit.* [4].

[6] *Loc. cit.* [2].

[7] *Loc. cit.* [4].

[8] Hort and Penfold. "Micro-organisms and their Relation to Fever," *Journ. of Hygiene*, October 21, 1912.

[9] Medical Research Committee. "Report on Cerebrospinal Meningitis," 1916.

THE EXTENT AND NATURE OF THE SENSORY LOSS IN MUSCULOSPIRAL PARESIS.

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The musculospiral nerve is one of the peripheral nerve-trunks of the body most commonly affected by injury. Especially often have lesions of it occurred during the present War—lesions either primary, due to actual contact with or proximity to the nerve of the foreign body in its passage into or through the tissues of the arm, or secondary, division anatomic or physiologic, complete or incomplete, due to such results of the entrance of the bullet or piece of shell as fractured bone, abscess development or formation and contraction of fibrous tissue. In a series of twenty cases of injury to nerve-trunks of the upper limb, collected by the writer during the earlier months of the War, the musculospiral was involved in six cases; in half of these it was the only nerve to suffer, in the other three there was a concomitant injury to at least one other trunk.

The musculospiral is the nerve-trunk of the upper limb, in which the area of sensory loss resulting from its complete division has given rise to most misunderstanding and discussion. Since the epoch-making discoveries associated with the names of Head and Sherren, and even before this, a more or less definite area, variable within certain small limits it is true with the position of the nerve lesion and with other different physical and anatomical conditions—but still a more or less definite area of sensory loss has come to be associated with and recognized and expected as the result of complete division of the various nerve-trunks of the body. The musculospiral nerve, however, is somewhat different; the area of its sensory loss is still a matter of controversy in many cases, and, as regards certain points, is far more variable—a variability depending apparently on more complicated anatomic and physiological arrangements, affecting not only the whole area of sensory loss in degree and extent, but also the relationship to each other of the areas of loss of epicritic and protopathic sensibilities. Indeed, one case of the present series seems to prove that to the general law of Head and Sherren that "in all peripheral nerves the fibres subserving protopathic sensibility have a much wider

overlap than those subserving epicritic sensibility," the musculospiral must be considered a possible, or at least an apparent, exception.

The writer using his six cases as illustrations proposes to study these variations in the sensory loss of the musculospiral nerve, and to see how far known anatomic connexions and hypothetical physiologic arrangement can be made to explain them.

The sensory loss when the nerve-trunk is divided in the lower third of its course in the arm below the point of origin of its external cutaneous branches:—

Many cases have been recorded of this lesion by various writers without the occurrence of sensory loss at all—notably Sherren's cases and one by Parry, where two inches of the nerve was destroyed in this position without loss of sensibility on the dorsum of the hand; indeed, Sherren writes "that complete division of the musculospiral nerve in its lower third produces no alteration in the sensibility of the dorsum of the hand."

The following case, although in it there is an accompanying ulnar paresis, fortunately not seriously affecting the points at issue, shows that it is possible that this may not be an absolute rule without exception. This point will be discussed after giving the case.

Case 1.—Division of ulnar and musculospiral nerves in the lower third of the arm, with an area of sensory loss in the hand. Private E. F., aged 24, was wounded by a piece of shrapnel casing in the lower third of the left arm on April 26, 1915. Septic wounds of entrance and exit resulted without the occurrence of any bony lesion.

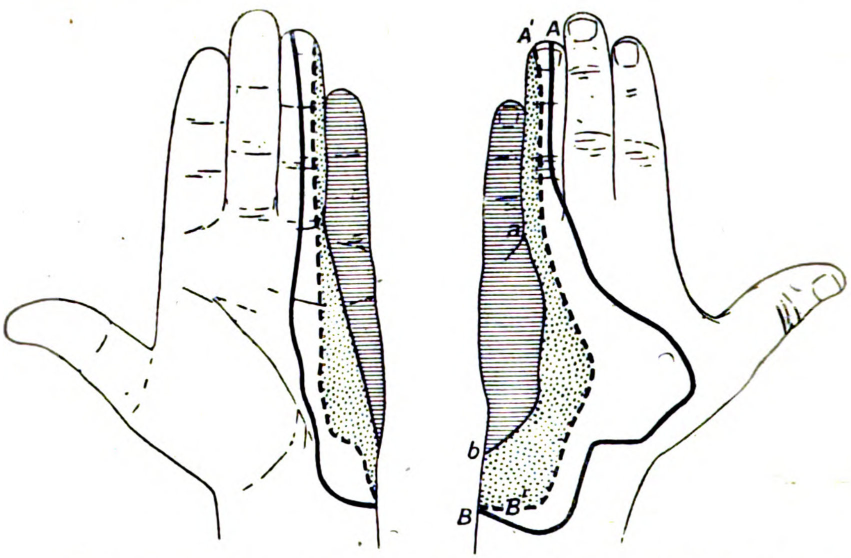
On examination, May 16, 1915, the following was found to be the condition:—

Position of Limb.—A combination of drop wrist and main-en-griffe.

Motor Loss and Powers.—Can flex all fingers at the proximal interphalangeal joints, can flex the three outer fingers, index, middle and ring fingers, at the distal interphalangeal joints; cannot flex the distal interphalangeal joint of the little finger; can adduct and abduct all the fingers, the interossei and hypothenar abductor of the little finger being felt to contract; can adduct the thumb; can extend the interphalangeal joints of the fingers, but cannot extend the interphalangeal joint of thumb; cannot extend the metacarpophalangeal joints; cannot extend the wrist, but can contract the biceps, triceps, and extensor carpi radialis longior.

Electrical Reactions of the extensors of the posterior interosseous group except the extensor carpi radialis longior; no reaction to faradism; with galvanism A.C.C. > K.C.C.

Sensory Loss.—As in Diagram I. From these data the diagnosis can readily be deduced; both from the position of the wounds and from the fact that the extensor carpi radialis longior contracts whilst the rest of the extensors give the reaction of degeneration, one diagnoses a complete division, anatomic or physiologic, of the lower third of the musculospiral nerve after it has given off its external cutaneous branches and the motor branch to the extensor carpi radialis longior. Of course in addition there is an incomplete ulnar paresis.



Case 1.—Diagram I: Area to ulnar side of line A B = area of epicritic loss; area to ulnar side of line A′ B′ = area of protopathic loss; area to ulnar side of line *a b* = area of deep loss.

When we come to study the sensory loss in this case (Diagram I) it will be seen that the area of loss of deep sensibility is merely that which occurs in pure ulnar paresis, but that the area of epicritic loss on the dorsum of the hand is considerably larger and extends further towards the radial border of the hand than if the ulnar nerve alone had been affected. Hence we have here a lesion of the lower third of the musculospiral producing an area of at least epicritic loss on the back of the hand; such however will occur, according to Sherren if the external cutaneous branches of the

nerve are cut as well as the nerve trunk below their point of origin. That this may have happened in this case is certainly a possibility; unfortunately because of the septic nature of the wounds and for other reasons operative investigation of this point was impossible. If these external cutaneous branches had also been cut, however, Cases 2, 3, 4, and 5, as will be seen—would certainly lead one to expect that in this case (1) there would have been an area of sensory loss along the back of the forearm, but this again, we shall see, need not necessarily follow the division of the nerve and its external cutaneous branches. Hence we must conclude that the evidence in this case, although suggestive of the possibility of a lesion of the lower third of the nerve alone producing an area of sensory loss, is indecisive.

It should be noticed in passing that in this case the area of sensory loss involves the ulnar rather than the radial half of the area on the dorsum of the hand supplied anatomically by the radial nerve.

The sensory loss where the nerve trunk is injured above the lower third of the arm—above the point of origin of its external cutaneous branches:—

In these cases all authorities are agreed that there occurs some sensory loss, although many hold this area of loss is limited to the dorsum of the hand and does not occur on the back of the forearm unless the posterior division of the musculocutaneous nerve is injured in addition to the whole musculospiral. The following cases however prove conclusively that this is not so and that an area of sensory loss may occur on the back of the forearm in complete musculospiral division in the absence of musculocutaneous division.

Case 2.—Complete division of the musculospiral just below the lower border of the axilla with areas of loss of sensation both in the forearm and hand.

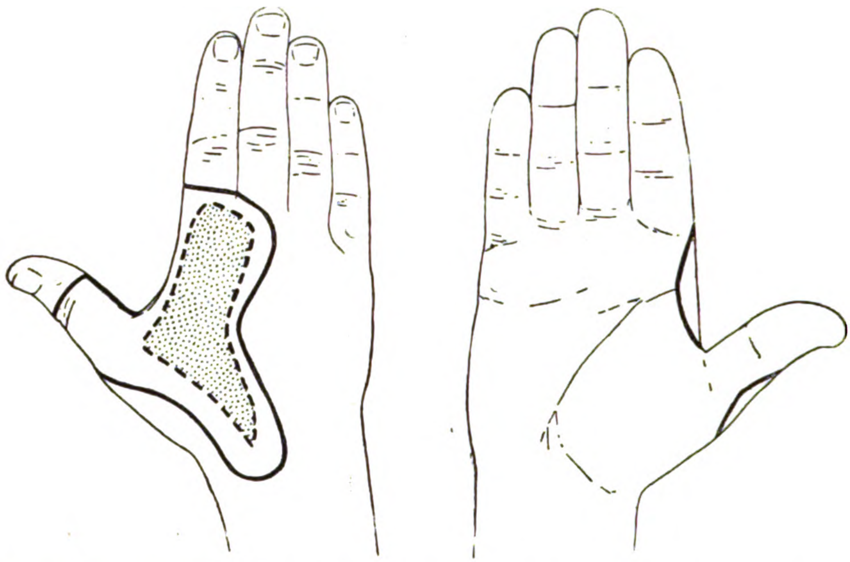
Private A. M., aged 30, was wounded on September 10, 1914, by a rifle bullet in the upper half of the right arm. Condition on examination March 17, 1915:—

Position of Limb.—Complete wrist-drop, forearm pronated, elbow flexed, wasting of long extensor muscles on the back of the forearm.

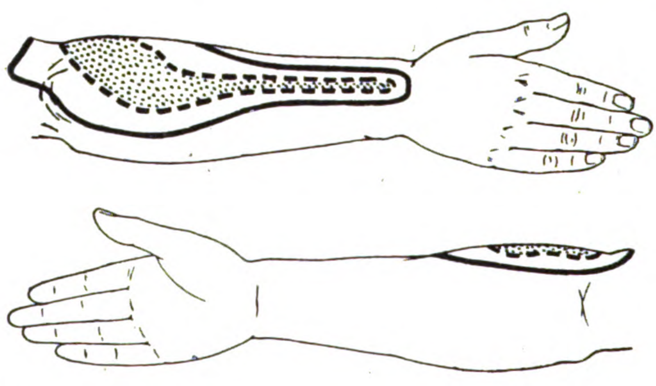
Motor Loss and Powers.—Cannot supinate, cannot extend metacarpophalangeal joints, nor wrist joint, nor interphalangeal joint of thumb; no contraction of supinator longus, very slight amount of contraction of part of triceps.

Electrical Reactions.—No reaction of paralysed muscles to faradism, slow contraction to galvanism.

Sensory Loss.—See Diagram II. No loss of deep sensibility, losses of epicritic and protopathic sensibilities as in Diagram II.



Case 2.—Diagram II (*a*): Areas of loss of epicritic and protopathic sensibility in hand.

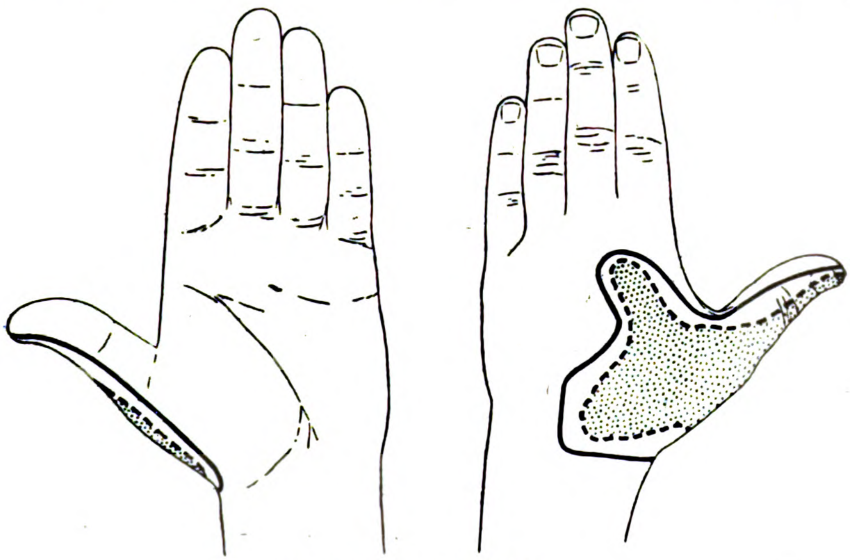


Case 2.—Diagram II (*b*): Areas of loss of protopathic and epicritic sensibility in the forearm.

Hence with these facts the diagnosis was complete, viz., division of the musculospiral nerve in the upper third of the arm after it had given off at least some of the motor branches to the

triceps. Subsequent operation showed this to be correct, the nerve being completely divided below the point of origin of the branch to the inner head of the triceps and only with difficulty were the two ends dissected out, freshened and reunited.

Here, then, is a case where from the position of the bullet wounds and track it was impossible for the posterior division of the musculocutaneous to be divided and yet a very considerable area of sensory loss, not only in the hand but on the back of the forearm, resulted from complete division of the musculospiral nerve in the upper third of its course. The same phenomenon is exhibited by



Case 3.—Diagram III (*a*).

Case 3.—Diagram III (*b*).

Case 3.—Complete division of the musculospiral secondary to compound comminuted fracture of the shaft of the humerus with areas of sensory loss in forearm and hand. Private H. C., aged 23, wounded on October 27, 1914, by pieces of shrapnel which produced

a compound comminuted fracture of the humeral shaft about its middle. On examination March 8, 1915, all wounds had healed and the following was the condition.

Position of Limb.—Complete wrist drop, great wasting of extensor muscles on the back of the forearm and of the triceps.

Motor Loss and Powers.—Cannot extend metacarpophalangeal joints nor wrist joint, triceps contracts feebly, supination performed by the biceps.

Sensory Loss as in Diagram III. In this case it was noticed that on shaving the forearm preparatory to testing the sensation there was a great accumulation of epidermis, the result of delayed desquamation over an area corresponding almost exactly with that of the epicritic loss as shown in the diagram.

At operation there was found in place of the musculospiral nerve mere strands of fibrous tissue partly embedded in and partly stretched over the callus. On stimulation of the nerve above the lesion there was no contraction at all of any paralysed muscle; in other words the block was complete.

Here again there was no question of simultaneous involvement of the musculocutaneous nerve.

Case 4.—Complete division of the musculo-spiral in the musculo-spiral groove secondary to a fracture of the humeral shaft with areas of sensory loss on forearm and hand.

Private J. O., aged 21, was wounded February 14, 1915, in the middle of the left arm by a piece of shrapnel which passed completely through the arm leaving septic entrance and exit wounds, and causing a compound fracture of the middle of the shaft of the humerus. Condition on examination, March 25, 1915:—

Position of Limb.—Wrist-drop, arm pronated.

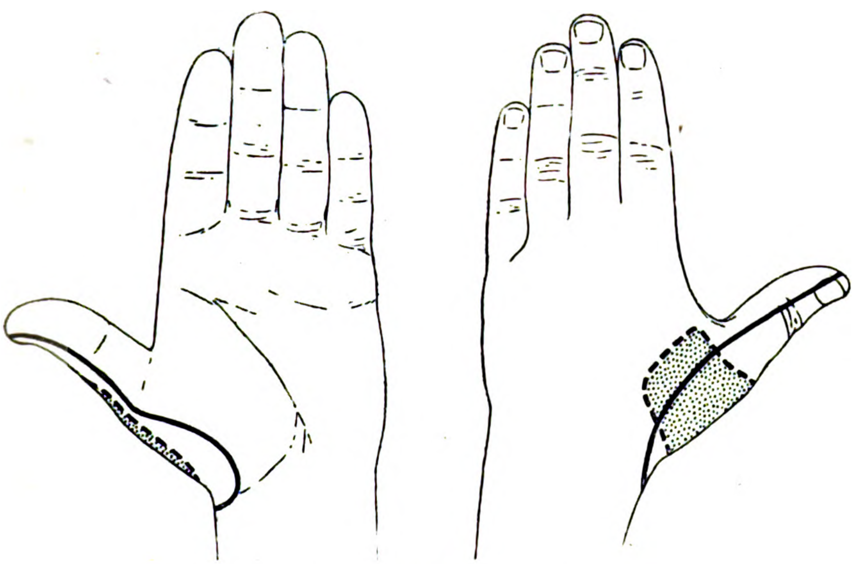
Motor Powers and Loss.—Cannot extend metacarpophalangeal joints but can extend all the interphalangeal joints, except that of thumb; cannot extend wrist; paralysis of the supinator longus; biceps alone supinates, triceps contracts.

Electrical Reactions.—The paralysed muscles do not contract at all on faradic stimulation. On galvanic stimulation A.C.C. > K.C.C.

Sensory Loss.—No loss of deep sensibility, areas of loss of epicritic and protopathic sensibilities as in Diagram IV.

The diagnosis is obviously complete division of the nerve above the lower third above the point of origin of the motor branch to the supinator longus and the external cutaneous branches. That this was correct was proved at operation, a complete anatomical division being found in the musculospiral groove.

Here, again, there is a case of complete musculospiral division without musculocutaneous division showing an area, smaller, it is true, than in Cases 2 and 3, of loss of sensibility in the skin of the forearm. This case is remarkable in that, as regards the area on the hand of sensory loss, the area of protopathic loss overlapped to a considerable extent the area of epicritic loss. This was tested over and over again most carefully, and ascertained to be so beyond doubt. To the discussion of this apparent exception to Head and Sherren's law relating to peripheral nerves we will return later.



Case 4.—Diagram IV (*a*).

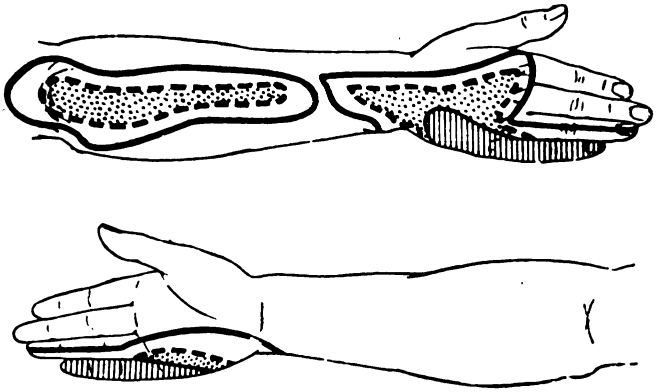
Case 4.—Diagram IV (*b*).

Case 5 shows the sensory loss that may occur with simultaneous division of the musculospiral and ulnar nerves in the upper half of the arm.

Private F. H., aged 33, was wounded on November 1,

1914, by a rifle bullet which passed through the inner side of the arm just at the lower margin of the anterior axillary fold fracturing the surgical neck of the humerus. On examination, March 17, 1915, the wounds had healed and the bone united.

Position of Limb.—Drop wrist; forearm pronated; elbow flexed; great wasting of one half of the thenar and all the hypothenar muscles and also the interossei, also the muscles on the back of the forearm.



Case 5.—Diagram V.

Motor Loss.—Complete paralysis of muscles supplied by the ulnar nerve. Inability to extend metacarpophalangeal, interphalangeal of thumb and wrist joints.

Sensory Loss.—See Diagram V.

Loss of deep sensibility as in pure ulnar paresis, cf., diagram I.; loss of joint sense in little finger only; loss of epicritic and protopathic sensibilities as in Diagram V.

Operation confirmed the diagnosis of complete division of the ulnar and musculospiral nerves. The lower end of the upper bony fragment was densely adherent, projecting inwards as it was, to the third part of the axillary artery, and the musculospiral nerve, on electrical stimulation of which proximal to the lesion no contraction of muscle occurred. The ulnar nerve was found in a mass of scar tissue with a spindle-shaped enlargement on it. Proximal electrical stimulation of it also produced no muscular response. This then is another example of complete division of the musculospiral nerve with an intact musculocutaneous, resulting in

loss of sensation over a considerable strip of skin on the back of the forearm.

It is interesting to compare the sensory loss area on the dorsum of the hand—or the musculospiral portion of it—in Case 5 with that in Case 1, where there was complete division of the musculospiral in the lower third; in Case 5 this area is much more extensive than in Case 1, although in both cases it is the radial portion of the area anatomically supplied by the radial nerve that retains its sensation. This, again, differs from what occurs in Cases 2 and 3 where it is in this radial portion of this area that sensation is chiefly lost.

Case 6.—The diagram of this case is instructive inasmuch as it shows the areas of sensory losses in a case of injury to the ulnar, median, musculospiral, internal cutaneous, and musculocutaneous nerves occurring just above the bend of the elbow in the lower third of the arm. In this case the external cutaneous branches of the musculospiral escaped.

Private F. H., aged 23, was wounded in the lower part of the right arm, a large piece of skin and muscle having been cut away from the antero-internal aspect of the lower third of the arm by a piece of shell. Investigation of his case on February 27, 1915, when the wound had completely healed, showed an incomplete division of the larger and deeper trunks—ulnar, median, and musculospiral, and a complete division of the subcutaneous nerves—the internal cutaneous and the musculocutaneous.

Diagram VI shows the various areas of sensory losses.

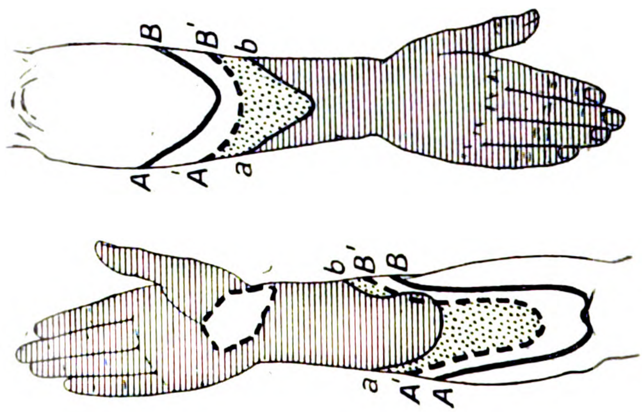
In this case we have the reverse of what obtained in Cases 2, 3, 4 and 5. In them there was division of the musculospiral nerve including the fibres which become the external cutaneous branches and no lesion of the musculocutaneous, resulting in an area of sensory loss extending from the level of the olecranon downwards a varying degree; in Case 6 on the other hand, division of the musculospiral, less the external cutaneous branches, but with musculocutaneous division, yields an area of sensory loss extending up the back of the forearm hardly more than half way and leaving with sensation intact a large part of the area affected in the other four cases. Compare here Diagrams II, III, IV and V, with Diagram VI.

Thus these five cases between them furnish a double proof that to produce sensory loss along this area in the forearm, it is not necessary, as some have maintained, that a musculocutaneous lesion should co-exist with a complete musculospiral above the lower third.

Résumé of facts exhibited by the cases:—

(1) In no case of pure musculospiral paresis is there any loss of deep sensibility.

(2) Complete uncomplicated division of the musculospiral nerve in its lower third results in most cases in no loss of cutaneous sensation, but it is not proved that this is an absolute rule, for case 1 suggests at least that there may in some cases result an area of sensory loss on the dorsum of the hand.



Case 6.—Diagram VI: Below line A B = loss of epicritic sensibility; below line A′ B′—except area C = loss of protopathic sensibility; below line *a b* = loss of deep sensibility.

(3) Complete division of the musculospiral nerve in its lower third complicated by simultaneous division of the posterior branch of the musculocutaneous, or the external cutaneous branches of the musculospiral, produces an area of sensory loss on the back of the hand (Sherren).

(4) Complete uncomplicated division of the musculospiral nerve above its lower third—above the point of origin of the external cutaneous branches—results in an area of sensory loss on the back of the hand; this alone in some cases (Sherren), but Cases 2, 3, 4, 5, 6, prove that in addition, without any simultaneous musculo-cutaneous injury there may occur an area of sensory loss on the back of the forearm.

(5) The area of sensory loss on the dorsum of the hand involves areas, both of epicritic and protopathic loss, and it varies in extent in different cases.

(6) This area on the back of the hand, in some cases lies more

to the radial side, and in other cases more to the ulnar side of the area of skin anatomically supplied by the radial nerve.

(7) Where division of the musculospiral nerve produces an area of sensory loss on the dorsum of the hand, Case 4 shows that the area of protopathic loss may overlap and extend beyond the area of epicritic loss, whereas it has always been held that in cases of injury to peripheral nerves the former area is included within the latter.

(8) Where there is an area of sensory loss on the back of the forearm it varies greatly in dimensions in different cases.

Hence we see that the variations in sensory loss in division of the musculospiral nerve may be classified as follows :—

(1) Variations in extent of the area of sensory loss.

(2) Variations in position of the area of sensory loss.

(3) Variations in proportion between the epicritic and protopathic loss areas.

Variations in Extent of the Area of Sensory Loss.—As regards the area of sensory loss on the back of the forearm, variations in its size are explicable on the ground of the known variations of size of the inferior external cutaneous branch of the musculospiral nerve; cases of the non-existence of this area in musculospiral paresis are probably cases where this inferior branch supplies a smaller area of skin than usual, and where the area it does supply is also supplied by overlapping of contiguous cutaneous nerves. In such a case, a definite area of sensory loss would occur only if the musculocutaneous or its posterior division were cut also.

In all cases of peripheral nerve division, of course, the area of sensory cutaneous loss—of epicritic loss—never equals in extent the area anatomically supplied by the affected nerve, this being due to overlapping and supply of the periphery of this anatomical area by nerves supplying the surrounding skin. As will be seen on referring to Diagrams I, II, III, IV and V, the area of cutaneous sensory loss on the dorsum of the hand is very variable in extent and shape; not only so, but it is in all these cases strikingly smaller than the "anatomical" area supplied by the radial nerve—very much smaller than one would expect to be explicable on the ground of ulnar or median overlapping. Indeed, as we have seen, it is in the majority of cases of musculospiral division in the lower third of the arm, if not in all, entirely absent. That this is not due to ulnar overlapping is made obvious by a glance at Diagrams I and V.

The explanation of this phenomenon lies in the fact that this area of skin "anatomically" associated in the mind with the radial

nerve, is really jointly supplied by at least two and sometimes by three different nerves—the radial, the musculocutaneous (posterior division) and sometimes also twigs of the inferior external cutaneous branch of the musculospiral. That this is so, is shown by a consideration of the facts with which we will be concerned in discussing the third set of variations in the sensory loss, as well as by the following:—

(1) Wounds of the dorsal surface of the wrist dividing the radial and the posterior branch of the musculocutaneous, and in some cases fibres of the inferior external cutaneous branch of the musculospiral, produce a large area of sensory loss in this area, while (2) division of the radial nerve in the upper third of the forearm produces no loss of sensation in this area; (3) division of the radial nerve in the lower third of the forearm, after it has received a communicating branch from the posterior division of the musculocutaneous produces an area of senory loss; (4) simultaneous section of the radial nerve and the posterior branch of the musculocutaneous, produces a smaller area of sensory loss than if the musculocutaneous and musculospiral in the upper third are cut.

Hence the variability in the extent of the sensory loss in these cases is evidently due to the fact that in some cases the musculospiral nerve supplies a larger, and the musculocutaneous a smaller area, whilst in others the opposite conditions obtain.

Variations in Position of the Area of Sensory Loss on the Dorsum of the Hand.—These variations in position, already noted, of the area of sensory loss, are probably due to this double—sometimes triple—supply of this particular area of the dorsum of the hand; where the loss lies to the outer side of the hand in musculospiral paresis most of the fibres of the latter nerve, including no doubt those of its inferior external cutaneous branch, probably supply this outer portion, whilst the majority of the musculocutaneous fibres pass to the inner portion, and where the loss lies more to the ulnar side the opposite conditions would again seem to occur.

Variations in the Proportion between Epicritic and Protopathic areas of Loss.—In this respect Sherren has described an apparently exactly similar phenomenon to that described in Case 4 and figured in Diagram IV as occurring as a result of simultaneous division of the radial and musculocutaneous nerves, viz., a dissociation of sensibility over a small area on the dorsum of the hand. He has ascribed this to the fibres of the inferior external cutaneous branch of the musculospiral supplying a greater area on

the dorsum of the hand with epicritic subserving fibres than that it supplies with protopathic, for, he writes, when the whole musculospiral is divided this dissociation of sensibility does not occur.

In Case 5, however, with complete division of the musculospiral this dissociation has occurred. Now in this case we have seen that the area of loss on the back of the forearm is very small. If this means that the inferior external cutaneous branch of the musculospiral is small, then most probably this nerve did not reach as far downwards as the wrist and fibres of it took no part in the innervation of the skin of the dorsum of the hand and hence did not have anything to do with the production of a dissociation of sensibility. In any case its fibres being divided with those of the main trunk of the nerve it could not have contributed to the production of this phenomenon, although since the musculocutaneous was intact, this does not mean that the inferior external cutaneous branch of the musculospiral does not always supply a larger area with epicritic than that it supplies with protopathic. This case, however, certainly tends to make one doubt the constancy of this arrangement.

Doubtless the explanation of this dissociation in Case 4 is, that in it the musculocutaneous fibres supply a larger area with epicritic than with protopathic sensibility, and the radial a larger with protopathic than with epicritic.

Hence we conclude that whilst this particular area of the skin of the hand is supplied by at least two and sometimes by three different nerves, section of one alone is insufficient to cause an area of sensory loss in it, Case 1 suggesting, however, that section of the radial—or lower third of the musculospiral—may in rare cases be an exception to this.

Moreover we must conclude that the proportion between the number of fibres subserving epicritic sensibility and the number subserving protopathic is not the same in each of the three paths by which such fibres may pass to the brachial plexus.

Clinical and other Notes.

A NEW SOLID MEDIUM FOR THE ISOLATION OF THE CHOLERA VIBRIO.

By Captain H. GRÆME GIBSON.
Royal Army Medical Corps.

Based on the fact that the cholera vibrio alone of all the intestinal organisms acidifies starch,[1] the following alkaline medium has been devised for the rapid isolation of this vibrio. Owing to the medium possessing differentiating properties it should be especially useful in the detection of "cholera carriers," as the fæces emulsified in broth can be plated directly on to it. In the case of water examination, after enrich-

The two emulsions are then mixed in a two-litre flask and another 500 cubic centimetres of water added. The solution is completed in the steamer. When dissolved the medium is clarified with white of egg and filtered in the steamer. The next step is to add the starch. If this is added direct to the peptone agar it forms a mass which it is almost impossible to dissolve. It is easily added if an emulsion is first made. Weigh out ten grammes of potato starch and emulsify it with some of the filtered agar. The emulsion is then added to the remainder of the medium. The whole is sterilized by the fractional method, after which enough sterile watery solution of litmus is added to bring about a blue colour of the medium.

[1] Gordon, M. H., "Note on the Ability of *V. choleræ asciaticæ* to decompose Starch," *Centralbt. f. Bakt.*, 1 abt., orig., bd. 42, 1906.

The final reaction of the medium will be found to be −2 to phenol phthalein. I tried several degrees of alkalinity and found that 0·15 per cent sodium bicarbonate gave quite the best results.

If the plates are examined eighteen hours after inoculation, by looking obliquely through them with a dark background behind, the plate being held parallel to the window, the cholera colonies will be seen to have acquired a faint pink colour, while the colonies of the other intestinal organisms are blue or of a whitish colour. The examination is facilitated by the use of a hand lens. At this time the allied vibrios also produce blue colonies, but at the end of about thirty-six hours they also acidify the medium, though to a less extent than cholera. At the end of twenty-four to twenty-six hours the cholera colonies have attained a delicate pink colour with a faint pink halo round them, while the other colonies still remain blue; also the colonies are of a good workable size to pick off and proceed with the serological tests.

After forty-eight hours, if the cholera colonies are in excess and the plate spread somewhat thickly, the medium itself becomes distinctly acid, and colonies other than those of cholera take on the pink tinge. However, the cholera colony even at this time can still be distinguished by the deeper red centre which the other colonies lack. The only other organisms which are known to acidify starch are some of the diphtheroid group and some of the non-pathogenic water vibrios. These should not present any great difficulty, as Gram's stain on the one hand, and the serological test on the other, dispose of these organisms. The following experiments have been carried out:—

Experiment 1.—Ten cubic centimetres of broth were inoculated by emulsifying some fæces in it. To this was added a very small quantity of a culture of *V. choleræ*. The tube was well shaken and 0·25 cubic centimetre of the broth transferred to a second tube of broth. Two drops of this broth were immediately plated on to the medium; the same rod being successively used for three plates. The first plate was too crowded to be of any use, but the second and third plates gave good discrete colonies, and on these plates the cholera colonies could be recognized in eighteen hours. Every colony on these plates was picked off, and all the pink colonies were proved to be cholera, whilst the blue colonies in every case proved otherwise.

Experiment 2.—The first broth tube from the previous experiment was kept at room temperature for two days. At the end of that time 0·25 cubic centimetre of this broth was added to ten cubic centimetres of fresh broth, and a drop of this was immediately plated out as in the first experiment. The plates were rather too thickly spread to give good discrete colonies, but the cholera colonies could be easily detected.

These colonies were again tested with cholera immune serum and the differentiation proved correct.

Experiment 3.—This experiment was undertaken to see whether any

of the normal water vibrios were capable of acidifying starch. The water was taken from a pond after heavy rain, and was taken straight to the laboratory.

Some of the water was first enriched by incubating in peptone water for a few hours. One drop of this peptone water was then plated and at the end of eighteen hours a few pinkish colonies were present.

Some more of the water was plated direct and in this case it took twenty-four hours before any pinkish colonies appeared. In both cases the pink colonies that were present were of a lighter shade than that which is produced by the cholera vibrio, and I do not think that they are very likely to be confounded with it. In addition the red centre to the colony that is produced by the cholera vibrio in forty-eight hours was not present in these cases. This organism proved to be a normal vibrio of water.

The following organisms were also plated out :—

B. typhosus.
B. paratyphosus A.
B. paratyphosus B.
Coliform organisms.
B. dysenteriæ (Shiga and Flexner).
B. enteritidis (Gaertner).
Streptococci.
V. Finckler Prior.
V. Metchnikovi.

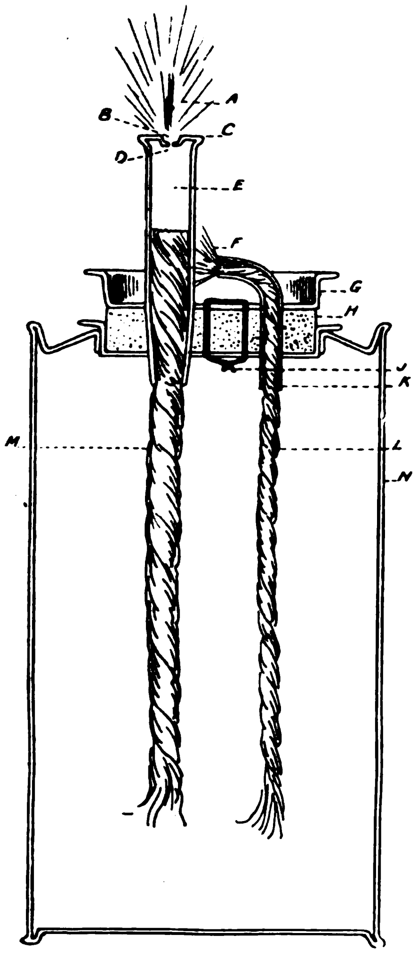
In no case did the above organisms acidify the medium except in the case of the two vibrios which produce a slight pink halo, but the colonies themselves, when viewed obliquely, do not become pink until a very much longer time has elapsed than that required tó recognize the vibrio of cholera.

A SIMPLE AND EASILY MADE ACTIVE SERVICE ALCOHOL LAMP—A SUBSTITUTE FOR THE BUNSEN BURNER.

By Captain LAWRENCE J. RHEA.
Canadian Army Medical Corps.

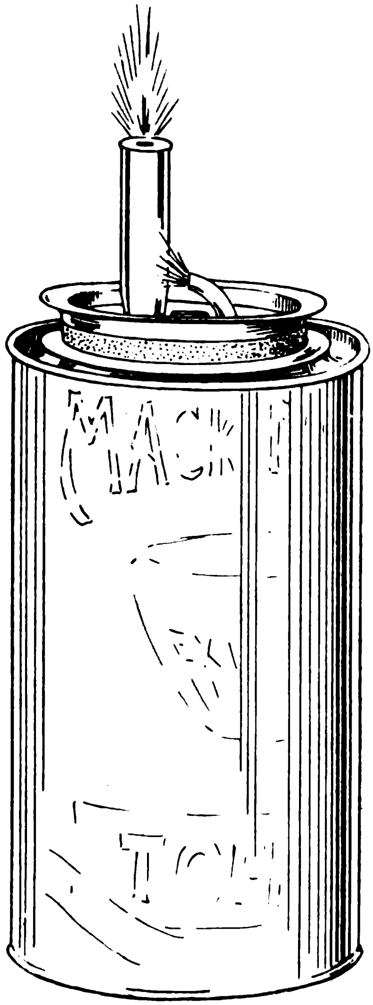
When hospitals in the field occupy tents, huts, or permanent buildings without gas connexions, some form of lamp for laboratory work has to be substituted for the ordinary Bunsen burner.

The most common types of lamps used are the ordinary alcohol lamp, and the automatic Bunsen burner for methylated spirits. Both are useful, though both have certain disadvantages. The chief disadvantages of the alcohol lamp are the comparatively small amount of heat it produces and the unsteadiness of the flame. The principal objections to the automatic Bunsen burner for ordinary laboratory work are: that it is not easily



Longitudinal section showing the construction and mechanism.

A, flame; *B*, depression for cap: *C*, rifle cartridge; *D*, opening in base of cartridge through which spark from cap ignites the explosive; *E*, empty space; *F*, pilot light; *G*, lid of Mackintosh's toffee tin; *H*, cork or soft wood; *J*, wire passed through two lids *G*, and cork; *K*, pull-through weight; *L*, wick to pull-through; *M*, wick to rifle cartridge: *N*, Mackintosh's toffee tin.



Substitute for the Bunsen Burner.

carried about; it takes some time to get it lit, and it requires constant care lest it get out of order.

I have made an alcohol lamp which has certain advantages over the two common types of lamps used in laboratories in the field. Its chief advantages are: it can be made in the laboratory from material easily available in any hospital in the field; the amount of heat produced is greater than in the ordinary alcohol lamp, though not as great as in the automatic Bunsen burner; it can be carried about as easily as an alcohol lamp; it takes but a moment to light, it is economical in the consumption of alcohol, the flame is steady, and the amount of heat it produces can be fairly well regulated.

This lamp is made from the following: one tin with a tight fitting cover, one rifle cartridge from which the cap has been removed, one pull-through weight such as is used for cleaning rifles, a piece of cotton tent rope, a circular piece of wood or cork, one small piece of wire, and a circular piece of tin.

Any tin with a tight fitting cover can be used, though I have found a Mackintosh's toffee tin the most satisfactory. This can be obtained at the British Expeditionary Force Canteen. The advantages of this tin are its size, shape, and the type of cover which is easily removed and makes the tin air-tight. It has this disadvantage, the joints are not soldered, and the tin will not hold alcohol until they are. On the top of the cover place a circular piece of cork or soft wood, one half inch in thickness. If a Mackintosh's toffee tin is used, this should be cut to fit into the depression in the cover. Over this, place a circular piece of tin, or still better, a second Mackintosh's toffee tin cover. Fasten the two covers and the intervening wood or cork together by a small wire passed through each of them in two places, and twisted on the inner surface of the cover that is to fit into the tin. Cut two holes through the three pieces that have been wired together, one of them near the centre, the other about half an inch from this hole. One hole should be of sufficient size to admit the open end of a rifle cartridge; the other a pull-through weight. If the cap of a large alcohol lamp is available the cartridge and pull-through-weight should be sufficiently close together to allow both of them to be covered by it. Both the cartridge and pull-through weight should fit tightly. A piece of cork, instead of soft wood between the two covers, as described above, makes this easy.

Cut the pull-through weight in two parts by filing it just beyond the rim that projects into its lumen and acts as a catch for the knot on the string which passes through it. The pull-through weight should be cut on that side of this rim that will give the longest piece of tube with a uniform calibre. Fill the longer piece with molten lead or solder. Allow this to cool; then bend one end of the tube at right angles, with the short arm of the right angle one-third to one-half an inch long. Heat the tubing to remove the lead or solder. This procedure is carried out

in order to ensure that there is no narrowing or distortion of the lumen when one end of the tube is bent at a right angle.

Make a wick of cotton tent rope, and pass it through the pull-through tube. This wick should fit snugly. Into the end of the rifle cartridge insert a snugly fitting, flat-end wick made from cotton tent rope, and pass it into the cartridge for a short distance. The end of the wick should not reach closer than one and a half inches from the base of the cartridge. The wicks of the pull-through weight and cartridge should be of sufficient length to reach to the bottom of the tin used to hold the alcohol. Insert the pull-through weight with its wick, and the cartridge with its wick through the holes made for them in the cover. Fill the tin with methylated spirits, and put the cover with its attachments in place. Light the wick of the bent pull-through weight. As soon as the heat from this, the pilot light, fills the chamber above the wick in the cartridge with volatilized alcohol, this alcohol escapes under pressure through the hole in the base of the cartridge, where it may be ignited. A small piece of cotton soaked in alcohol and placed against the cartridge near the pilot light will, when ignited, light it, and hasten the volatilization of the alcohol brought into the cartridge through its wick. The height and size of the flame, and therefore the amount of heat produced, can be regulated, either by adjusting the wick in the pilot light, or turning this light to one side so that only a small part of its flame plays upon the cartridge. By these means I have been able to hold a water bath at 56° C. for eight hours with a variation of less than half a degree.

I have used French, English, and German rifle cartridges. The French and English cartridges that I have seen have two holes in their base through which the spark from the cap ignites the explosive, and as a result, they give a lower and a broader flame than the German cartridge I have used which has only one such hole. A high and narrow flame may be obtained from either the English or French cartridge by plugging one of the holes in its base with a gramaphone needle or the end of a pin. If a German cartridge, or an English or French cartridge with only one of the holes in the base left open, is used, it may be necessary to enlarge the hole a little if a comparatively large flame is desired. Unless this is done, the volatilized alcohol may escape under a pressure sufficient to blow out the flame. When it is desired to put the flame out, drop a small tin or the cap of an alcohol lamp over both burners.

The flame produced by this lamp is almost colourless and, like all flames from volatilized inflammable materials escaping under pressure, very hot.

I have found this lamp to fulfil satisfactorily all the ordinary requirements of a Bunsen burner.

I am indebted to T. A. Croft for the drawings which illustrate this paper.

A NOTE ON IRRITANT DERMATITIS AMONG SOME MUNITION WORKERS.

By GEORGE PERNET, M.D.

Dermatologist to the West London Hospital and Lecturer on Dermatology, West London Post-Graduate College.

I HAVE had several cases of picric dermatitis among my out-patients, all but one in women. In the case of the man, apart from the yellow discoloration of the skin, hair and nails, the dermatitis was limited to a few patches on the forearms. In the women, the dermatitis has been more widespread, involving not only the arms and forearms, but also the face and neck, and in some instances, the upper part of the chest. The degree of the dermatitis has varied, the face and orbits being sometimes much swollen, accompanied by oozing and some crusting of the affected areas, like an eczema. The workers who are vulnerable to the picric dermatitis are usually attacked soon after starting the work—a week to ten days. The urine was examined in two or three cases: no carboluria.

The diagnosis, I need hardly say, is readily arrived at on the grounds of occupation and yellow discoloration (tri-nitro-phenol).

These cases I have found respond quickly to a local application of lead and calamine as follows:—

℞ Lot. Glycerini plumbi subacetatis (i.e., glycer. plumbi subacet. ℥i.; aq. dest. ad ℥viii)
Lot. Calaminæ.. .. .. āā

When the dermatitis is severe, I also order a mixture as follows:—

℞ Sodii bicarb... .. .. .. gr. xxii
Aq. .. .. .. ad ℥i

taken effervescing by the addition of

℞ Pulv. acidi citrici .. .. .. gr. xv.

three times a day ten minutes before meals.

The general directions are to avoid soap and water to the affected parts, which are to be cleaned up occasionally with a little salad or olive oil (*not* cotton-seed oil). Cold winds and exposure of the face are also to be avoided.

I have found that this class of case readily clears up on the foregoing simple lines. There is nothing very original or startling about the treatment, and plain lot. calaminæ might do as well. But I am only giving my experience.

In a recent case, the woman had been employed on picric first (discoloration) then on other "powders" before the acute dermatitis of the face and forearms broke out. Probably this was due to tri-nitro-toluol (T.N.T.), the ground having been previously baited by handling the tri-nitro-phenol preparation. In this case plain lot. calaminæ did good.

I have not seen any relapses in the patients attending my department,

but this may be explained by the fact that they may have been put on to other work. The rule is that once the face and orbits have been affected by a dermatitis of the irritant or eczematous type, the patient becomes sensitized (anaphylaxis) to any fresh provocation from without; and at times from within too (disturbances of the alimentary tract, ptomaine intoxications, etc.).

In addition to the above cases I have had four patients (women) referred to me for a similar kind of irritant dermatitis (face and forearms) apparently due to the varnish or lubricant coating American fuses. These women had not been employed on explosive powders, but on these fuses only ("stripping" was the word used), so I take it there can be no doubt as to the origin I have mentioned. The dermatitis in them appeared in from three days to a fortnight after starting the work.

These cases did well on the same treatment, viz. :—

℞ Lot. Glycer. plumbi subacet.
Lot. Calaminæ .. .. āā

and an effervescing mixture of citrate of soda.

I am contributing this note in the hope that it may perhaps be found of some service.

A NOTE ON SOME CASES OF BLOOD INFECTION BY AN ANAEROBIC ORGANISM SECONDARY TO WOUNDS.

By Temporary Lieutenant ADRIAN STOKES.
Royal Army Medical Corps.

During the months of October, November, December and January, while doing bacteriological work in connexion with the clearing hospitals, a series of cases in wounded men occurred giving the same clinical and bacteriological picture. The clinical picture was characterized by four separate features: first the colour of the patient, which was a dirty yellow, something like the colour of a dirty deal table; secondly, the very soft running pulse, which was always very rapid, often uncountable, and in the later stages irregular; thirdly, uncontrollable vomiting; and fourthly, the very rapid onset of the condition after the injury. The presence of obvious gangrene at the site of the wound was inconstant. In three of the six cases reported it was present, in the remaining three it was absent. Death occurred in every case with great rapidity, forty-eight hours being the average time; one case survived eighty hours. The patient was always conscious to the end and in a state of "euphoria." It appeared probable from the great similarity of the symptoms and the invariable result in every case that there might be a common cause. The presence of the bacillus of malignant œdema was suggested as the probable explanation; an attempt to isolate the organism from the wounds having failed in two cases, it was thought that it might be found

in the blood stream, and accordingly blood cultures were made in the series of cases reported. In six cases a culture was obtained by this method of an organism which was indistinguishable from the *Bacillus aerogenes capsulatus.* The blood cultures were made in three cases immediately after death from the hearts' blood, and in the three remaining cases the blood cultures were ante mortem. In two cases which died after a week in hospital of typical gas gangrene, the culture was negative; in one case ante mortem, and in the other case post mortem. The former case had been twice operated upon in attempting to stay the spread of the gangrene; in the latter case it was thought that the patient would not stand re-amputation. In this case the culture was ante mortem and gave a positive culture of *Staphylococcus aureus.* These two cases seem to make it probable that the series in which positive cultures of an anaerobic organism were obtained may be a separate and distinct condition. The number of cases in which it was possible to verify the diagnosis of blood infection by culture is small; on the other hand, there were no negative cultures in cases which were regarded as typical of the condition.

The six cases in which blood cultures were positive were as follows:—

Name	Number of cubic centimetres	Place	Hours of survival after wound	Time of blood culture	Projectile wound
Pte. W.	4	Braisne	50	P.M.	Shell; compound, femur.
,, R.	4	Poperinghe	40	,,	Shell; compound, femur.
,, B.	4	,,	60	,,	Bullet; compound, humerus.
Major B.	4	Lillers	48	A.M.	Shell; compound, humerus and femur.
Lieut. C. M.	1	Bethune	80	,,	Bomb, arm; no fracture.
Pte. L.	4	Lillers	40	,,	Shell; compound, femur.

The technique adopted was the same in all the cases; shake cultures in glucose agar were made as soon as possible after the blood was taken, at the same time ordinary aerobic blood plates were made which in every case were negative at the end of forty-eight hours. In the shake cultures bubbles of gas were observed in all the cultures on the next day. In five of the positive cultures gas appeared with great rapidity; in two it was apparent in six hours, and in three it appeared in ten hours. The culture was profuse and the formation of gas abundant, the agar being forced to the top of the tube. Growth ceased within an inch of the surface of the medium and seemed most active about two inches from the surface. The organism was a Gram positive bacillus, most of the bacilli taking the Gram well, a few individuals losing the strain and a

few showing a beaded appearance. The bacilli varied a good deal in length, forms longer than anthrax being common, and forms as short as *B. coli* were found. It did not form spores in glucose agar and died out in one week in that medium. In one culture (Major B.) capsules were stained; in the others they were apparently present but it was not possible to stain the actual capsule. The colonies were dense and opaque, and on McLeod's plates made with blood glucose agar they showed a distinct hæmolytic power. The organism is non-motile. It was possible by making use of the hæmolysis to isolate the same microbe from two quite harmless wounds, one in the leg, the second in the thigh. One culture (Major B.) killed a guinea-pig in fifteen hours, the culture (Lieut. C. M.) made a pig very ill but it did not die; these were the only cultures injected into animals. There were a large number of cases presenting the same clinical picture in which it was not possible to do blood cultures to verify the diagnosis. From the very rapid onset of the symptoms it was probable that the infection of the blood stream is either at the time of injury or very soon after it.

A BRIEF ACCOUNT OF THE METHOD OF PROVIDING BATHS FOR THE BRITISH SOLDIER IN THE FIELD.

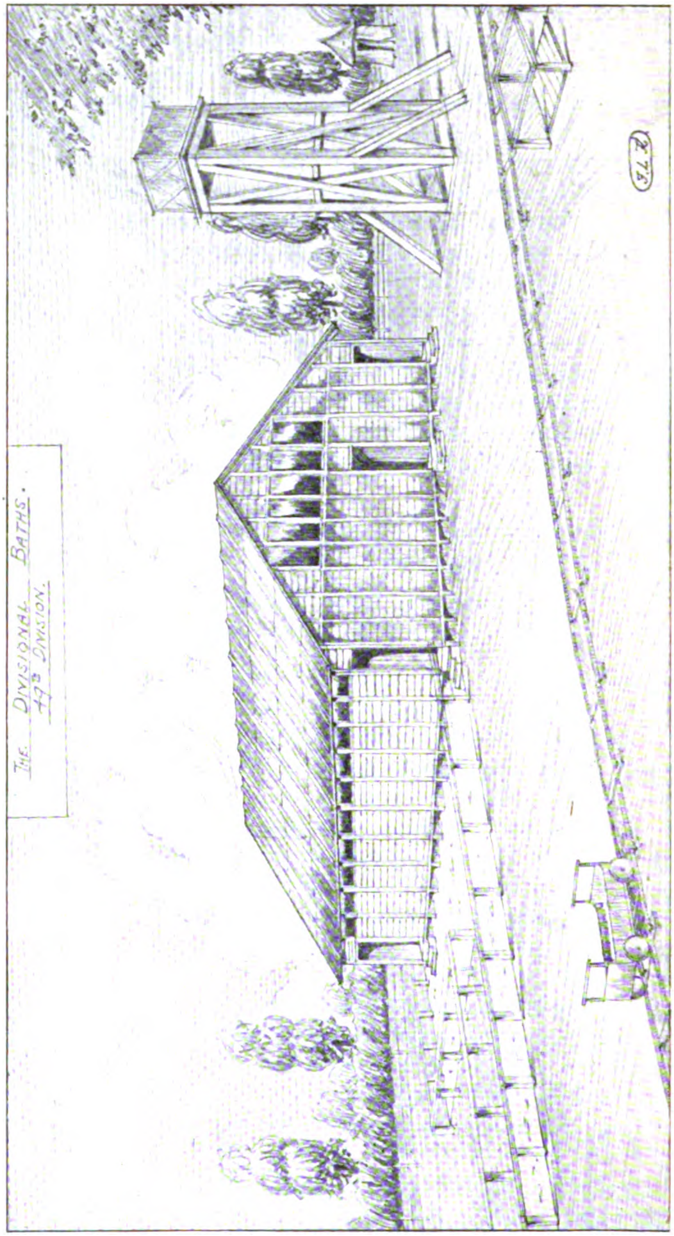
By Captain H. NORMAN GOODE.
Royal Army Medical Corps.

Cleanliness, as is well known to those who have been in the trenches, is a matter of the greatest difficulty under the present conditions. Men have to remain in the trenches without any opportunity of washing or changing their clothes. In consequence, they get covered with lice, chiefly *pediculi vestimentorum.* These cause great irritation, and rob them of the few hours well-earned sleep when off duty. The lice inhabit chiefly the shirt, pants, and trousers, in which millions of eggs are laid in a very short space of time. To alleviate this, arrangements are now made throughout the British Army for the men to have baths and a change of underclothing as soon as they come out of the trenches.

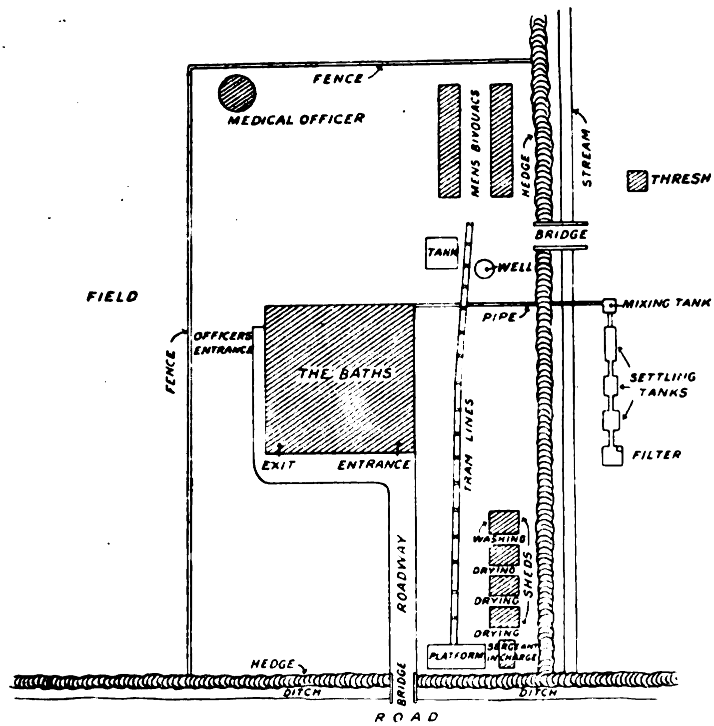
The following is the method adopted by the —— Division:—

I will first give a description, together with a plan of the baths themselves, then the routine of bathing the men, and, lastly, the method I have devised, in conjunction with Captain Basil Hughes, of Bradford, for purifying and using the water over again an indefinite number of times.

As regards the building itself, a plan is subjoined. The canvas structure, with which I originally commenced, has now been replaced by a portable wooden building. This was kindly presented by the West Riding of York County Association through the instrumentality of Lord Scarborough and General Monds.


THE DIVISIONAL BATHS.
47th DIVISION.

From the ground plan it will be seen that it consists of a large undressing-room, a bath-room with eight showers, the officers' shower bath, a large dressing-room, a room for soiled underclothing, a store-room for the issue of clean clothing, a boiler-room, and, lastly, an ironing-room for the purpose of destroying the eggs and lice in the khaki clothing.

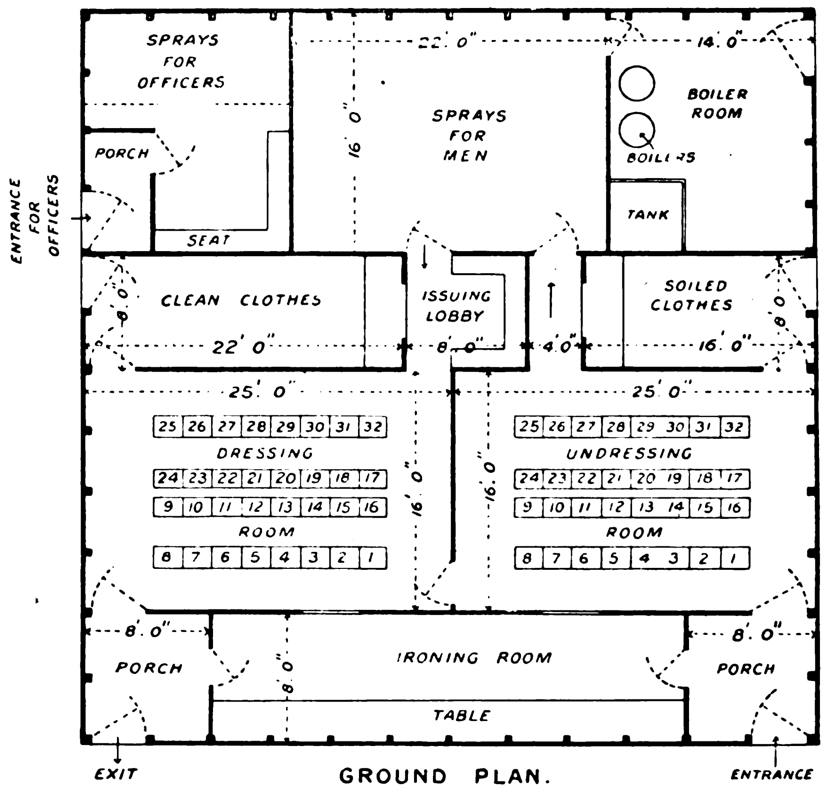


BLOCK PLAN.

The water is pumped by means of a little petrol engine into a 1,600-gallon tank, 24 feet high; thence it runs by gravity to the two connected tanks which feed the boilers, which are independent of one another. The water—hot, cold, or mixed hot and cold—feeds the eight sprays by gravity, sprays being used to economize water, since only 1½ to 2 gallons are required per man instead of six when using tubs.

Originally every drop of water had to be carried to the baths by means of a motor tank, holding 120 gallons, from a stream about 1½ miles away; as, for convenience of the troops, the baths had to be placed in a field some way from the nearest brook. Now, however, there are three

sources—a shallow well, providing some 1,000 gallons a day; a storage tank, containing water brought from the stream and rain-water from the roof: and lastly, the concrete well, containing the purified used water. The process of purifying the used water I will describe later. These three sources are connected up to the motor pump. Thus any one may be used separately to supply the elevated storage tank.



GROUND PLAN.

The method employed for bathing the men is as follows: 2,000 men can be bathed *per diem*. The maximum in one day, so far, has been 2,050. The men are sent to the baths in batches of 50 to 75 every half hour, commencing at 8 a.m. and continuing until 12 noon; then again from 2 p.m. to 6 p.m. The men come to the baths without arms as a rule. Here they undo their puttees and boots, and take off their tunics. They then enter the undressing-room in batches of thirty-two, and undress. Their breeches are then handed into the ironing-room,

where they are ironed in order to kill the lice and nits. The trousers are usually put through the Thresh disinfector. The men, in batches of sixteen, then pass through to the sprays, handing in to the soiled clothes room their shirts, socks, and pants. Three minutes is the usual time allowed under the hot sprays, during which time they soap themselves all over, the last half minute being used to wash off all the soap. In the summer the last half minute consists of a cold shower. Thence they go into the dressing-room, being served out on the way with a clean shirt, a pair of pants, and a pair of socks. Meanwhile, an attendant has brought round their boots, tunics, and other belongings from the undressing-room to the dressing-room, placing them on a number corresponding with that from which they were taken, the numbers being painted on the tables. When dressed they leave by the exit door and form up outside, another batch of sixteen immediately following through in the same order. Thus it will be seen that the underclothes are pooled. These shirts and pants are put through the Thresh disinfector in lots of eighty for twenty minutes to half an hour at a temperature of 216° F. Twenty minutes suffices if a bottle of formalin has been poured into the Thresh disinfector. The clothes are sorted and the rags burnt. The following morning the rest of the clothes are conveyed in wagons to a distributing centre in a village eight miles away. This is the nearest available place where spring water abounds and where labour is obtainable away from the firing line. Here a responsible woman sorts and distributes the clothing to fifty washer-women who boil, wash, dry, iron, and mend them, and then return them tied up in bundles of ten to the distributing centre. The same wagons, after being washed with cresol solution, return to the baths with loads of clean clothes, each batch of clothes being returned on the third day. Several thousand new shirts, pants, and socks are required monthly to replace wastage.

The last point of interest is the method of using the water over again. This is of the highest importance for two reasons: Firstly, clean water, or even water of any kind, is very scarce in this part of Belgium in summer. Secondly, it is highly objectionable to pour 2,000 to 4,000 gallons of soapy water into the ditch near the baths. If this were allowed, it would accumulate and decompose in the hot sun; since, owing to the flatness of the country, there are no possible means of draining it away.

The following method was devised by Captain Basil Hughes and myself after a number of experiments with a working model.

I give here a ground plan and a sectional plan of the method.

From these it will be seen that the soapy water runs from the bath-house into a mixing-tank. Slaked lime is placed in this tank, and thoroughly mixed by means of a windmill mixer, coustructed from a couple of old bicycle wheels and a hop-pole. When the wind fails, the mixing must be done by hand; but this is hard work. The lime throws

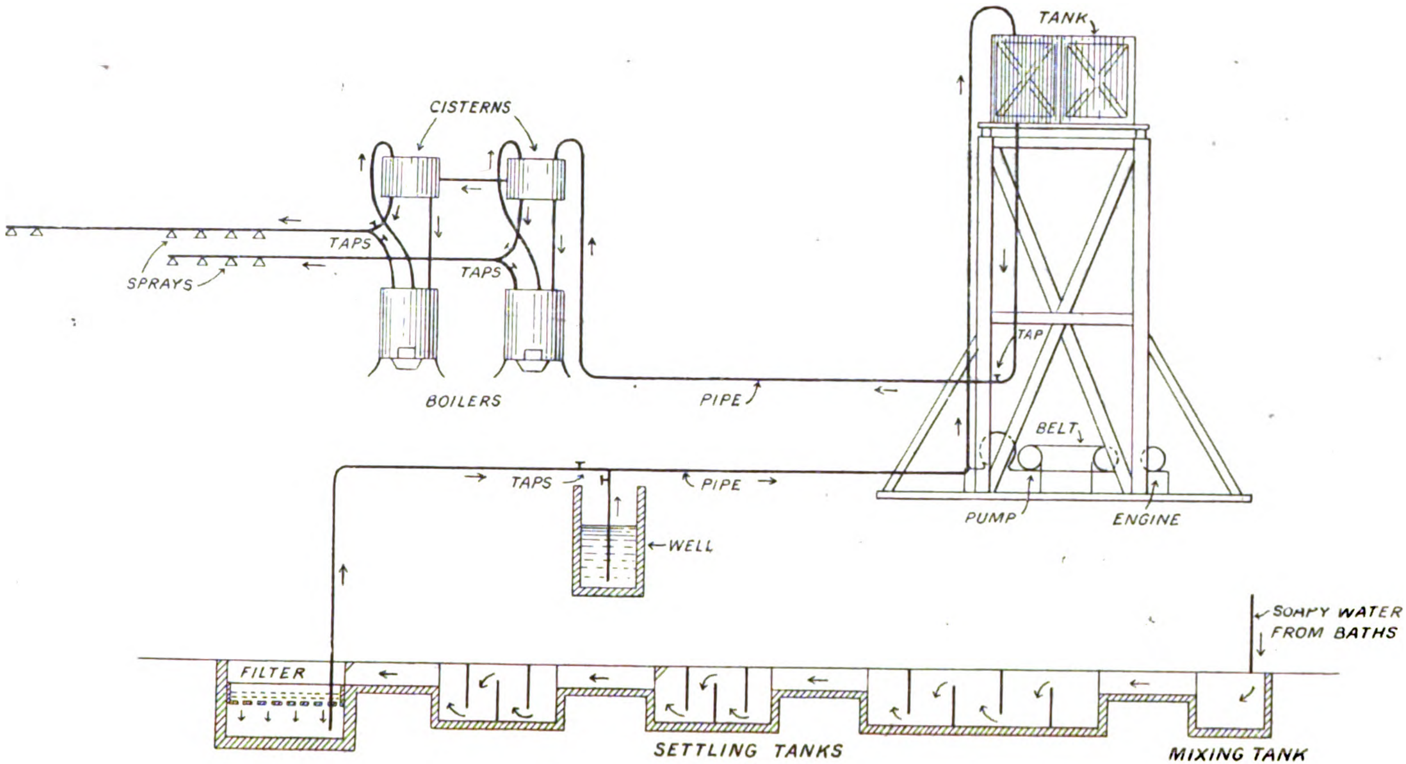
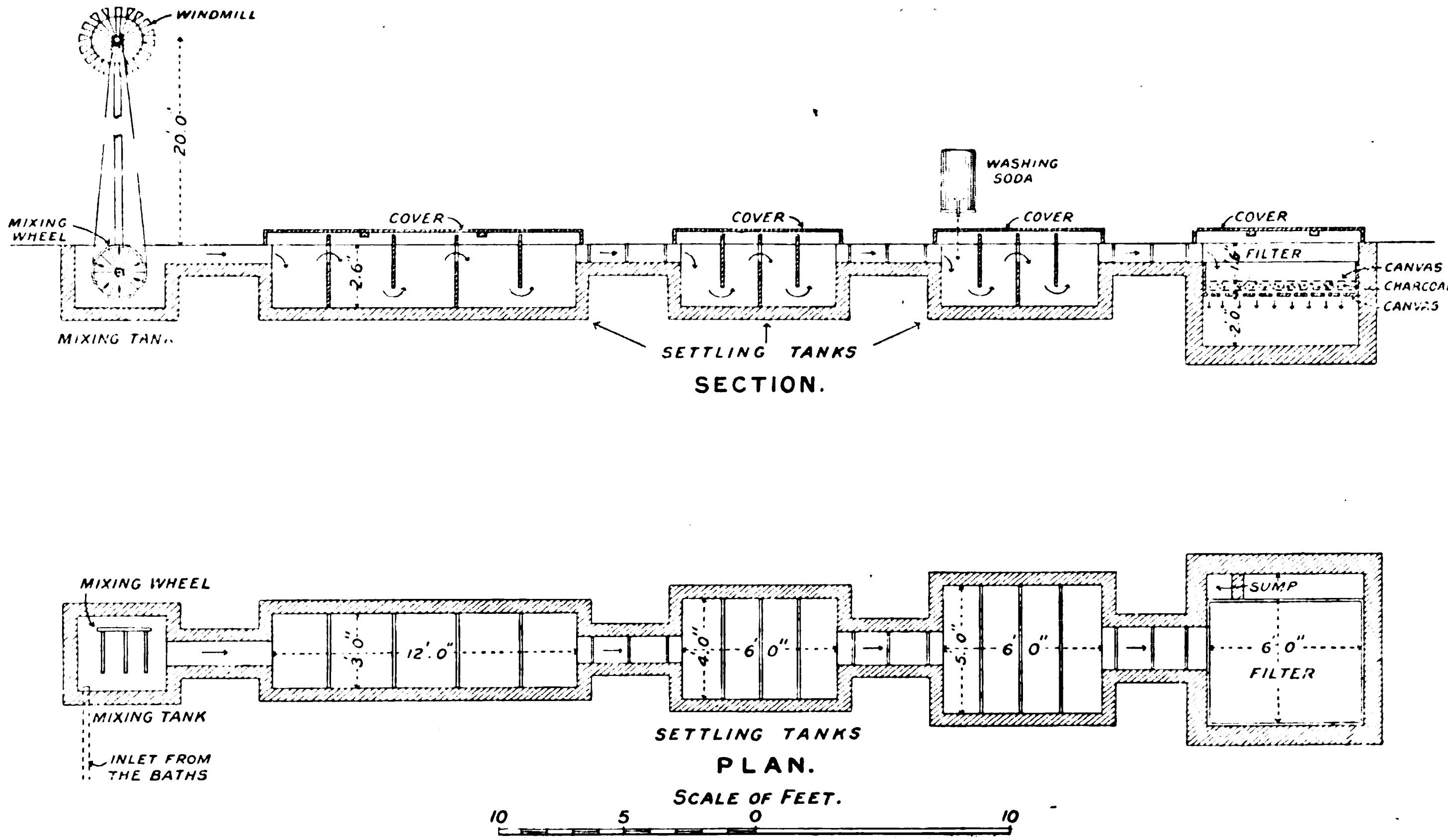


Diagram showing Water Supply.


WINDMILL
20.0
MIXING WHEEL
MIXING TANK
COVER
COVER
COVER
COVER
2.6
WASHING SODA
FILTER
1.6
CANVAS
CHARCOAL
CANVAS
2.0
SETTLING TANKS
SECTION.
MIXING WHEEL
MIXING TANK
INLET FROM THE BATHS
3' 0"
12' 0"
4' 0"
6' 0"
5' 0"
6' 0"
SUMP
6' 0"
FILTER
SETTLING TANKS
PLAN.
SCALE OF FEET.
10
5
0
10

The Filter.

down the soap as insoluble calcium stearates, bringing down at the same time all the dirt and impurities. The effluent runs through three up and down settling-tanks, placed all on the same level. These are built of brick with concrete floors. The partitions are removable wooden frames with canvas centres. The three settling-tanks are respectively 3, 4, and 5 feet wide. This gradual widening of the tanks tends to retard the flow of the stream, thereby assisting precipitation. All the calcium stearates will be found to have settled down in the first two tanks. The third tank is used for precipitating the lime and removing the soapy oils. This is effected by means of washing soda, which is run into the tank from a drum containing a saturated solution of sodium carbonate. This precipitates the calcium salts—chiefly hydroxides—as insoluble calcium carbonate, which immediately falls to the bottom of the tank. In addition to this, the sodium carbonate causes the soluble oils from the soap to separate out. These oils, which give the water an odour of soap, float on the surface, and are absorbed by means of canvas or sacking nailed on to wooden frames. The canvas is changed daily. From this third settling-tank the water flows into a charcoal filter, containing four inches of powdered charcoal between two layers of sacking. Through this filter it runs into a bricked, concreted well, and is pumped thence into the elevated tank by the petrol pump. Thin canvas screens, stretched on strong wire frames, are placed in the channels connecting the precipitating-tanks. These hold back the scum of lime which separates out on the water cooling. The first precipitation-tank is cleaned out every three or four days, and the mixing-tank daily. The sludge is buried. The sludge, which is odourless except for a slight smell of lime, does not show any tendency to decompose. The water, after treatment, is quite clear, free from dirt, soap, lime, and soapy oils; and furthermore, it gives a good lather with soap on being used again. The same water may be treated by this method and used an indefinite number of times. The only fresh water required is that to replace the loss caused by cleaning the tanks. No great quantity, however, is requisite, since most of the contents of each tank can be pumped into the succeeding one until the sediment is reached.

In experimenting with the working model, in order to ascertain the size of the charcoal filter required for dealing with 4,000 gallons a day, it was shown that the rate of flow through the filter varied directly as the height of the superimposed column of water. A charcoal filter six feet square was found to be adequate. This filter consists of a wooden frame six feet square and eighteen inches high, lined with zinc. The floor, made of zinc, is perforated with holes of medium size. The latter is covered with sacking, on which a layer of powdered charcoal four inches thick is spread. This is covered with sacking, which is changed and washed daily.

A separate bath-room for officers, on the same principle, has now been added, and as many as thirty-five in one day have taken advantage of it.

The system I have described is characterized by its easy method of construction, its simplicity and mobility. It has now been working for several months, and its results have proved satisfactory in every way. I can strongly recommend this method as highly suitable where large numbers of men have to be dealt with, and more especially in these places where water is scarce.

Reviews.

Maintenance of Health in the Tropics. By W. J. Simpson, C.M.G., M.D., F.R.C.P. London: John Bale, Sons and Danielsson, Ltd. 1916. Pp. xi and 174. Second Edition. Price 3s. net.

This is an excellent little book. It is pleasantly written, the information conveyed terse and accurate, and the advice it gives as good as can be. One minor criticism only do we allow ourselves. It is, surely, time that the cholera-belt were definitely consigned to the limbo for other fatuities. How the risks of life in the Tropics are to be lessened or its amenities increased by wearing a poultice (which is what it comes to) round one's middle is one of those things that is past finding out. Its use is founded on a tradition, itself based on a false pathology, and the present reviewer looks back with satisfaction to the colitis he cured and the other symptoms of abdominal congestion he relieved by the simple expedient of advising its discontinuance. H. R.

Rural Sanitation in the Tropics. By Malcolm Watson, M.D., D.P.H. London: John Murray. 1915. Pp. xvi and 320. Price 12s. net.

It was in 1880 that Laveran announced his discovery of the parasite of malaria, and in 1898 Ross, working to Manson's idea that a certain species of mosquito (Anopheles) was the intermediate host of the organism, published his brilliant series of researches, tracing its life-history, and demonstrated the accuracy of that skilful induction. By the work of the United States Commission in 1900, it had been proved that yellow fever is spread by another mosquito (*Stegomyia fasciata*)—a theory held and advanced by Dr. Finlay, of Havannah—and though, in this instance, the micro-organism (probably of an ultra-microscopic variety) is yet to find, the extinction of the offending insect has practically abolished the disease in such areas where proceedings to that end have been practised.

Prior to these discoveries and the practical work thereon established, a book on the subject under review might well have been nearly as brief as one on snakes in Ireland.

Dr. Malcolm Watson, under the somewhat drab title he has chosen, is now, however, in a position to set down some of the first-fruits of these pregnant labours, and that almost the whole of his book is taken up in dealing with the problems to which they give rise, is proof, if any be wanting, how futile would have been the task had it not been informed by the directing principle that was born of the researches of Ross and his predecessors; for it need hardly be stated that malaria and its congeners were and are the great crux that faces the sanitarian working in the rural districts of the Tropics. Nor is it, even now, so simple as it might seem.

The scientist, it is true, has established the broad fact that a certain species of mosquito was the intermediate host of a parasite that infected man and produced malaria, and that its removal would consequently spell the subsidence of the disease; but, there's the rub! There are many varieties of the incriminated insect, each with its characteristic habits of life and being. Some thrive in swamps, others in hill-side streams, and others again in the puddles of the roadside, while some,

especially that species responsible for the spread of yellow fever, live in water-butts or in any small collections of water in the neighbourhood of human dwellings. Thus, malaria driven from the plains by cultivation and drainage did not yield to the same treatment when it had its abiding place in the hills. Furthermore, regard must be paid to contingent conditions. Measures such as extensive drainage and cultivation suited to the eradication of the disease in districts likely to remain populous would necessarily differ from those adapted to its temporary suppression in areas where there was less prospect of permanent and extensive occupation. Therefore it will be seen, as the author emphasizes, while the principle holds the problem of its application varies. Anxious to learn how difficulties were met and overcome in other districts than in the Malay Peninsula, where, it may be interposed, his own work had been crowned with success, Dr. Watson made a pilgrimage through many lands, and the result of his investigations are here set down. He visited British India, but for reasons that may be surmised the record of his observations there are brief. Thence he proceeded to the Dutch Colony of Sumatra, where he seems to have been most struck with the excellence of the accommodation provided for the sick and for scientific research into prevailing disorders. Thereafter he passed to the Panama Canal Zone which presented a rich field for inquiry, and his plain unvarnished account of the amazing results reached there by Colonel Gorgas, U.S.A., in making possible one of the great engineering feats of modern times makes fascinating reading. Here, in an area, in extent about fifty miles by five, the major part swamp and all fever-ridden, so great had been the death-rate in imported labour, that more from this cause than from inherent engineering defects, had the great undertaking of Lesseps failed. Not all the genius of United States engineers, great though that may be, could have completed the work had it not been for the labours of the American scientist who had made Havannah from a place of pestilence to one meet for the dwelling-place of man.

In 1906 we are reminded that owing to an outbreak of yellow fever, there would have been no labourers left on the Isthmus had there been ships available to take them away so great was the fear of the epidemic then raging, and yet, since that period by the organized and unceasing efforts of the sanitary staff in clearing jungle, removing all collections of water in the neighbourhood of dwellings, screening houses, oiling the surface of tracts and sources of water the risk from which could not be removed by other means, trapping insects and fumigating systematically houses and villages, not only was the plague stayed—there have been no cases since that year—but the ravages of malaria were reduced to a faint shadow of their previous proportions. In 1906, the admission into Hospital per 1,000 of the labour force was 821, in 1913 it was 96!

It is, as we have said an amazing record, nor, as Dr. Watson points out, is all the story told when the bald facts of the reduction of the malaria rate and the disappearance of yellow fever are stated, for it seems to be an established fact that a high malaria rate indicates a low health standard, and a higher consequent mortality from all disease.

Short visits were paid to British Guiana and the malaria problem is discussed with special reference to the existing conditions, and to Barbados where the curious absence of the malady engaged the author's serious attention. Local belief attributes more influence to the existence

of a minute fish ("millions") in controlling the growth of the larvæ of the mosquito than Dr. Watson is inclined to concede, though he advocates experimentation on a large scale to settle the question. He himself is inclined to attribute the local immunity to the coral structure of the island, the soil being thus of so porous a character that the land is sufficiently drained to prevent the formation or, at all events the long persistence of small collections of water. He indicates, by the way, that Barbados will stand to run special risk in the near future when the Panama Canal traffic is in full swing, and we gather that he is not of opinion that all that might be done is done to prevent the grave calamity which would arise, as things are—the not improbable introduction some day of yellow fever into the island.

Dr. Watson's book ends, curiously enough, not so much as might be surmised, on a note of enthusiasm on the scope for and prospect of success attending the work that lies before the sanitarian in tropical countries as on one pointing out that in the opening up of a colony there is much to be done in settling its political conditions before he can effectively enter the field. Armies and police to protect the inhabitants and keep the peace, railways and canals to promote intercourse, trade, and the distribution of food are, he warns us, of more pressing importance than the labours of the health officer, and when it is remembered that it is as a health officer that Dr. Watson writes, we must concede to him an even higher title to be heard—viz., that of one who does not look merely on things from his own angle of vision and coloured by his own predilections, but as one who "sees life steadily and sees it whole."

The book is enriched by many excellent photographs and it is couched in a style that makes pleasant reading of a sufficiently engrossing theme.

H. R.

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Original Communications.

THE TREATMENT OF WOUNDS IN WAR BY MAGNESIUM SULPHATE.

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AND

LIEUTENANT WILLIAM J. TULLOCH,

Royal Army Medical Corps.

Lecturer in Bacteriology University of St. Andrews.

THE nature of wounds produced during the present War has materially altered the views of surgeons, and made inadequate methods of treatment to which they have long been accustomed in civil practice. The ordinary technique of wound treatment fitted for civil hospitals has been found wanting in military surgery. We have grown so accustomed in virtue of the antiseptic and aseptic treatment of wounds, both before and after operation, to expect in a healthy wound healing without suppuration that when confronted with wounds already infected, as gunshot wounds are, we were unprepared to alter our methods of treatment to cope with such new conditions as have arisen.

The wounds caused during the present European campaign are very different to those which occurred during the South African War, and there appear to be two main points of difference:—

(1) *The Environment.*—The seat of War in South Africa, was a vast track of virgin soil, sparsely populated, uncultivated, except

26

in the neighbourhood of towns and rivers, and so particularly free from organisms. The climate, except during the rainy season, was exceptionally dry, the air was free from moisture and the soil over which our armies passed was sandy and mostly stony or rocky. The sun shone brilliantly all day and almost every day, and in such condition septic infection of wounds was the exception rather than the rule.

In Flanders and Belgium almost opposite circumstances prevail. The land has for generations been laid out for intensive cultivation and is therefore well farmed, it is thickly populated and enriched by manures—the excreta of men, horses, and cattle. Such a soil lends itself to the growth of very mixed and generous flora of organisms, and when one considers that it is in surroundings such as these that the trenches are dug, and in which our armies are living and fighting—their clothes and persons contaminated with a highly infected mud and soil, one ceases to wonder that the conditions of the wounds are so changed for the worse. Also the rainfall is great and the amount of sunshine comparatively small.

(2) *The Nature of the Wounds* is also materially different to those seen in the South African War because the character and construction of the projectiles causing them are changed.

In the Boer War a bullet fired from a Mauser rifle was the chief cause of wounds. This bullet had a blunt rounded point of almost the same circumference as its base, and as it was usually fired at a considerable distance, the bullet had time to settle down in its flight and to get rid of the "wobbling," which occurs in a bullet fired at less than 300 yards. The result was a clean cut hole both at the points of entrance and exit with little bruising of the tissues between. Even when a bone was struck it was generally pierced by a hole such as would be bored by a gimlet, and attended by little or no splintering. The present German bullet, in contrast to this is, more frequently than not, fired at close quarters either from rifle or machine gun, it is conical in shape with a sharp point so that the centre of balance is moved further back towards its base. The "wobble" therefore in this bullet is greater than in the one previously described, and it is more easily turned off the straight. Coming in contact with any resistance—soft tissues and more especially bone—the bullet is listed sideways, or in some cases makes a complete somersault, so that its base travels first and acts as a modified "Dum-dum." It follows that though the wound of entry may be small like the "bug-bite" characteristic of the South African War, it is exceptional for the wound of exit to be a

small, clean-bored one. The characteristics of the exit wound are ragged edges and some tissue carried away. In addition the amount of tearing, bruising and concussion to intervening tissues is such that their resisting power is so lowered that they form a suitable nidus for the growth and development of organisms carried into the wound.

A still more important difference is due to the fact that the prevailing type of wound caused in this War, in contrast to that in South Africa, is produced by shells which vary in type from the heavy "Jack Johnsons" to the hand bomb, and all the wounds caused by these are ragged and attended with loss of tissue with an area round the wound necrotic and devitalized. Fragments of shell are rough and jagged, and carry with them into the wounds highly septic material, along with portions of clothing, mud, etc.

The added difficulty experienced in collecting the wounded, with the result that they have sometimes to lie for long unattended, wet and covered with mud, explains the difficulty in getting rid of much of the wound infection.

These altered conditions in modern warfare have produced changes in the opinions of surgeons as to the treatment of wounds. One change clearly indicated is that the aseptic surgery to which we are accustomed in civil hospitals has not first place in military surgery. In exceptional cases the wound is of such a nature that if not interfered with it heals without suppuration or constitutional disturbance if painted with Tr. iodi. and the first field dressing applied, but this cannot be relied upon. The antiseptic treatment of wounds is up to the present limited in its usefulness—Lister recognized that it was of the greatest prophylactic, but of little curative value. There should, in consequence of his work, be no doubt that in the early stages of wound treatment the antiseptics indicated by him are capable of dealing with sepsis so long as the organisms have not gained an entrance into the deeper tissues. But it is only under these conditions that they are useful. In employing antiseptics sufficiently powerful to destroy organisms implanted in a wound, as he pointed out, these chemical substances also lower or even destroy the vitality of the tissues with which they come in contact, and so may provide a more suitable and extensive field for the further development of the organisms for whose destruction they are employed. The antiseptic chosen in the early stages of treatment is of importance. It has been our practice in recent wounds, both of bone and soft parts, to swab the wound freely with pure carbolic acid, packing it afterwards for

twenty-four hours with gauze steeped in carbolic lotion (one in twenty). This together with free and dependent drainage has been frequently successful in obviating or minimizing sepsis. This is followed at the end of twenty-four hours by the application of the magnesium sulphate treatment to be described later. Recently there has been a tendency to rely on hypochlorous acid, in the form of eusol, or Dakin's solution, as an antiseptic, and it is said that either, while exercising a powerful bactericidal effect when brought in contact with infected tissues, has no injurious effect upon them.

Their usefulness, like that of all antiseptic substances, is probably limited to cases in their early state and, so far as our experience guides us, they are not good throughout the course of treatment.

Attention has been drawn by Sir Almroth Wright and others to the employment of *hypertonic solutions*, i.e., substances which produce a copious flow of lymph from the tissues with which they come in contact and by causing a vis-a-tergo, wash the discharges and organisms out of the wound, dilute the toxins, and render them comparatively harmless.

It is to our practice for early infected wounds treated as soon as possible in France, and later in septic and suppurating cases in England by magnesium salts in various dilutions, that we seek to draw attention.

From a clinical point of view hypertonic solutions, to produce their ideal results, must have the following properties:—

(1) They must not be easily absorbed.

(2) They must stimulate the growth of granulations in the whole of the wound and these granulations must be firm, compact and vascular.

(3) Their applications to wounds must be simple and easy, and the changing of dressing containing them infrequent and painless.

The application of magnesium sulphate fulfils these requirements. It is not absorbed, the granulations formed under it are ideal, the dressings, even in the most septic cases, need only be changed twice a day, and its use is painless. It has the additional advantage of being cheap, readily procured, and easy to handle.

Lieutenant Tulloch has undertaken much experimental work, and his results, recorded later, offer, in addition to points of clinical interest, experimental evidence of the value of magnesium sulphate as a surgical dressing in septic cases.

In no case so treated has there been any symptom of absorption (pain, thirst, diarrhœa, rise in temperature).

Secondary abscesses and lymphatic infections have not occurred. Many patients have expressed their satisfaction as to the painlessness of the dressings. The only instance in which a suspicion of absorption arose was the following case:—

Pte. E. B. was admitted into the Northumberland War Hospital on September 14, 1915, suffering from a wound of the left gluteal region, which was supposed to have penetrated the abdomen. Abdominal section was performed on August 26 in France for peritonitis.

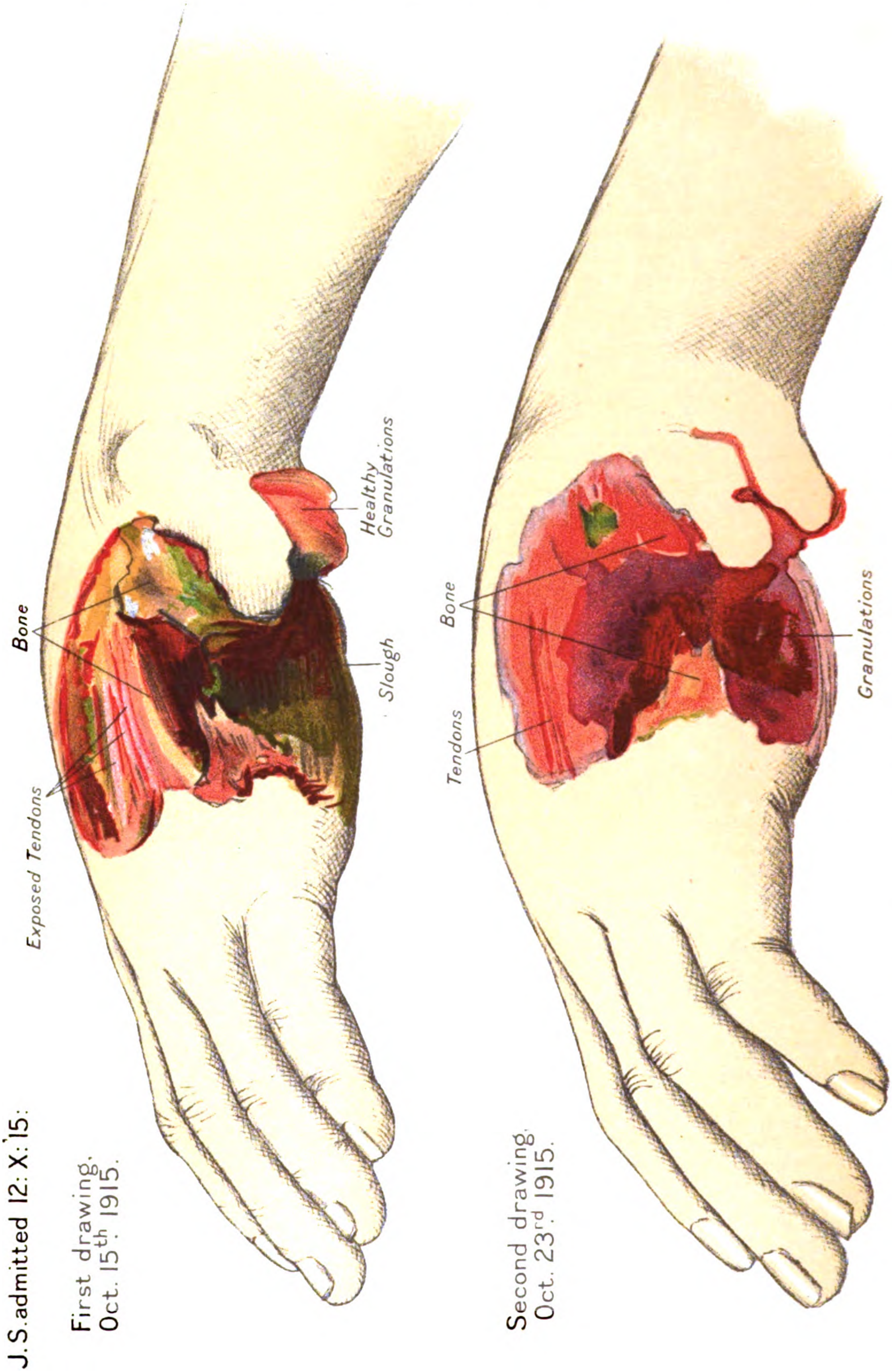
On admission: There was a wound the size of a threepenny-piece in the left gluteal region, and a large granulating wound about the size of the palm of a hand in the middle line of the abdomen below the umbilicus. The margins of the abdominal wound had been drawn together with sutures, but had broken down, and in the centre of the wound was a fistula discharging fæcal matter in such quantities that the wound had to be dressed five or six times a day. The surrounding skin was raw and ulcerated. The abdomen was flaccid, and the patient did not complain of pain. Magnesium sulphate dressings were applied, and ordered to be changed twice daily. Oleate of zinc ointment was applied to the excoriated skin. September 20: The wound had cleaned up considerably, the granulations were healthy, and the wound was closing in. October 1: Patient complained of diarrhœa coming on about every two hours. It had no reference to food, and as it was thought it might be due to absorption of magnesium sulphate, the dressings were changed to spirit gauze and wool, but as this produced no cessation of the diarrhœa, he was carefully dieted, and chlorodyne and bismuth given medicinally. This arrested the diarrhœa. The magnesium sulphate dressings were reapplied, and there were no further symptoms. October 29: Wound quite healed, but there was a space between the recti muscles filled in only by peritoneum and dense scar tissue. January 8, 1916: The scar was excised by an elliptical incision, and, in doing this, the peritoneum was opened at the upper angle of the wound. The anterior rectus sheaths on each side were incised through the whole length of the incision, about ¼ inch from the middle line. The opening in the peritoneum was closed with a continuous catgut suture, and the two inner flaps of rectus sheath with figure-of-eight sutures of the same material, so that this portion of the sheath covered the whole of the exposed peritoneum. The rectus muscles, with the outer portions of their sheath, were brought together with quilted sutures of catgut, and a finer continuous suture of catgut approximated the edges. The skin was

closed with silkworm gut sutures and horsehair. The wound healed, and except for slight subcutaneous hæmorrhage caused no further trouble.

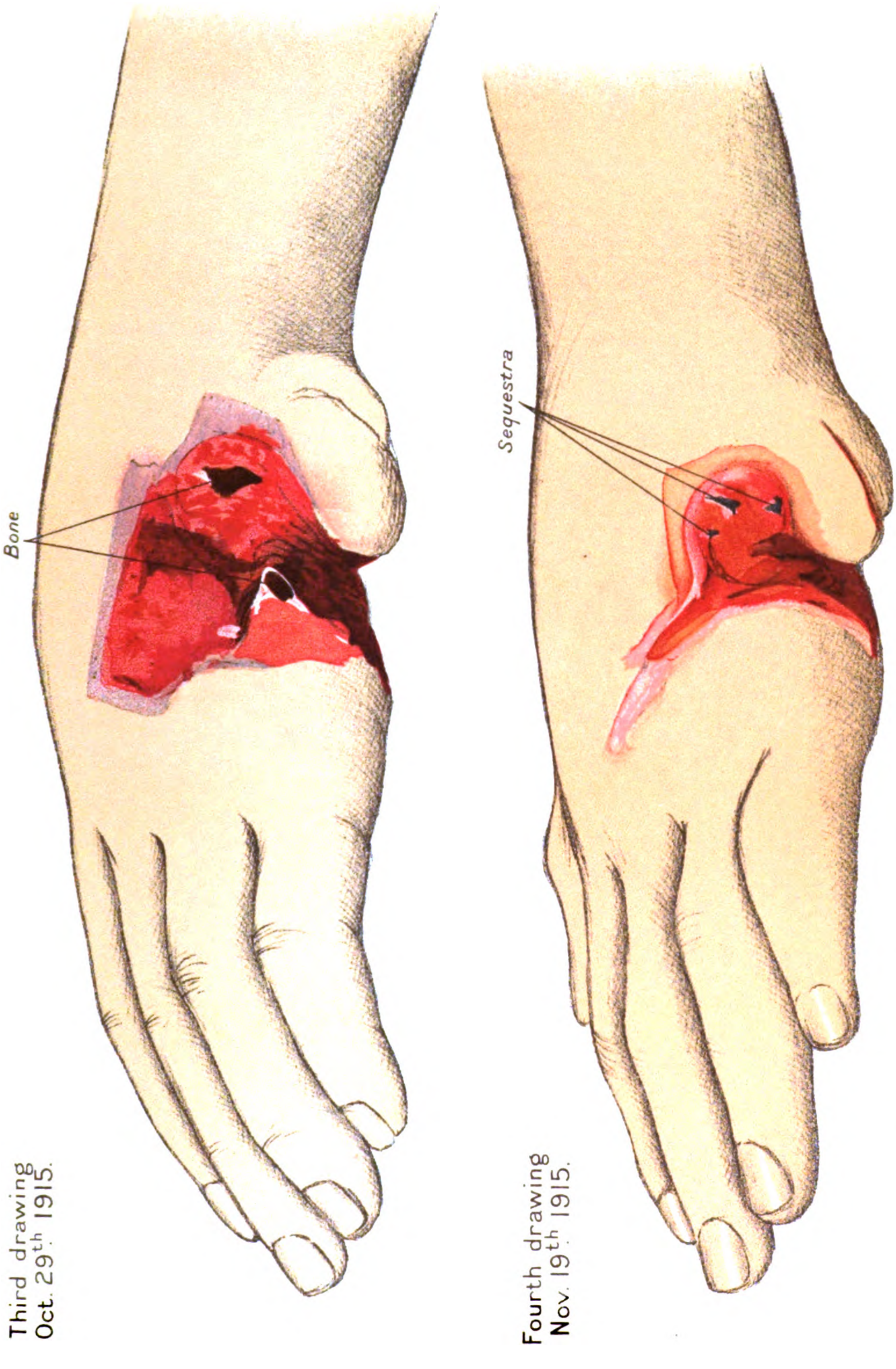
The type of granulation produced by magnesium sulphate is such that very little absorption is possible from it. A sloughing suppurating wound is converted under it in a few days to a bright red flat, compact, granulating surface, which lends itself to the rapid growth of epithelium from its edges. In deeper wounds, and where the bone is injured or laid bare, a similar result may be anticipated. It is the rule that sepsis is held in check, suppuration disappears, healthy granulations soon cover the bare bone and tendons, and the amount of necrosis is diminished or even entirely prevented. The following cases may be offered as ordinary examples:—

Gnr. G. W. was admitted into the Northumberland War Hospital on August 17, 1915, suffering from a gunshot wound of the head. The notes supplied accompanying him from France were: "August 7: Shell wound right parieto-frontal region with small gutter fracture of bone. Osseous lesion slight, involving only the outer table. No injury to inner table. Dura intact and brain pulsating well. Had slight weakness of left leg and loss of abdominal reflexes on the left side probably due to concussion."

On admission: There was a wound, about 1½ inch long, unhealthy, and suppurating profusely over the right fronto-parietal region. Encircling this was a horseshoe-shaped incision with base anterior, the operation wound. The flap was as large as the palm of a hand. The stitches were still in situ, and two drainage tubes passed right under the flap. The stitches and drainage tubes were removed, and the wound was opened up in its entirety. The whole of the exposed bone, about 4 inches by 3 inches, was white and bare. Lint steeped in magnesium sulphate solution was loosely packed under the scalp. The whole wound was covered with lint wet in the solution, with jaconet and absorbent wool superimposed. It was ordered to be dressed twice a day. August 21: The wound was much cleaner, discharge less profuse, and granulations were showing in places on the bare bone. As we were at this time trying magnesium chloride solution of strength 1 to 8 on all septic cases in our wards, this was substituted for the sulphate solution. August 25: Wound much cleaner, but granulations more flabby, and bled more freely. Stronger solution (1 to 4) of magnesium chloride applied. August 27: Patient developed a sharp attack of erysipelas of scalp and face. Dressings changed to magnesium sulphate solution, and lint steeped in it applied to the whole face and



To illustrate "The Treatment of Wounds in War by Magnesium Sulphate," by ALBERT E. MORISON, F.R.C.S., and Lieutenant WILLIAM J. TULLOCH, R.A.M.C.



To illustrate "The Treatment of Wounds in War by Magnesium Sulphate," by ALBERT E. MORISON, F.R.C.S., and Lieutenant WILLIAM J. TULLOCH, R.A.M.C.

head. For some days the patient was seriously ill, with high temperature and delirium, but gradually the attack subsided, and on September 30 he was able to be out of bed.

From the date of the reapplication of magnesium sulphate, the wounds rapidly improved, pus disappeared, healthy red firm granulations covered the exposed bone, none of which was lost by necrosis. When the whole bone was thus covered, the scalp flap was replaced, and by October 30 the wound was entirely healed.

The development of erysipelas in this case decided us to give up the magnesium chloride and return to the magnesium sulphate in all cases.

It seemed to us that in the presence of weak, flabby granulations, such as the chloride produces, absorption of fluids is probable, and the passage of organisms becomes easy.

If free and dependent drainage is made, and the wound packed loosely with lint soaked in magnesium sulphate solution, the necessity for drainage tubes no longer exists, for the hypertonic action is such as to wash out discharges from the wound, prevent the formation of pus, and establish a healthy granulating surface.

The growth of epithelium from the edges of the wound is stimulated, the resulting scar is firm and mobile, and very little contraction takes place. (See diagrams.)

Pte. J. S. was admitted into the Northumberland War Hospital on October 12, 1915, suffering from a wound on the left hand caused by the bursting of a bomb.

On admission: There was an extensive lacerated wound on the inner and back part of the left hand. The metacarpal bone of the little finger had been almost entirely blown away, and the extensor tendons were freely exposed. The skin was hanging loose into the sloughing, gaping wound. He could move all the fingers slightly except the little finger, but could not move the wrist joint.

X-ray examination showed the proximal end of the fifth metacarpal bone missing. There was also a fracture of the unciform bone. The wound was dressed with magnesium sulphate dressings, and the drawings show the subsequent progress of the case. Several small sequestra were removed on January 5, 1916, and the wound healed rapidly. The little finger remained frail and useless.

The healthy granulating surface also formed a good, aseptic, vascular base for skin grafting.

Lance-Cpl. A. M. was admitted into the Red Cross Hospital on September 28, 1915, suffering from a shell wound of abdominal wall. On admission there were three wounds, the largest on the right

side of the abdomen below the costal margin, about the size of a cheese plate; a second below this in the right iliac fossa and a third in the right groin. None of them were deep. All were suppurating freely.

Treatment.—Magnesium sulphate dressings were applied and on October 27, when healthy granulations existed, the wounds were covered with Thiersch skin-grafts taken from the right thigh. A cage of perforated zinc was fastened over the grafts and a sterile towel over the top of this so that no direct dressing was applied to the grafts. On November 5: cage removed, all grafts were holding and a dressing of weak icthyol ointment was applied. November 25: patient discharged from hospital.

The dressing of septic wounds is not as a rule easy and is accompanied by special discomfort and pain to the patient so that complicated apparatus and frequent changing of dressing, anything that causes more than ordinary inconvenience, is undesirable and may be harmful.

The application of sulphate of magnesium dressing is painless and easily carried out and the dressings, even in the most septic cases, need only to be changed twice a day.

The condition of the wounds when convoys arrive from overseas demands attention. The dressings generally consist of gauze which has been moistened with some solution and covering it a quantity of cotton wool. The wound, soon after the application of such a dressing, becomes dry from evaporation, so that difficulty is experienced and pain caused by removing the dressings which have become adherent to the wound. In the deeper wounds discharges are pent up and the condition of the patient and the wound suffer. The simplicity of application of magnesium sulphate, and the infrequent changes of dressing necessary, allows of several cases being attended to in a short time, and makes it the ideal dressing for wounds where the transport of the patient is necessary, and these deleterious results are likely to happen.

Mode of Preparation.—A saturated solution of the salt has given the best results, both clinically and experimentally—forty ounces of magnesium sulphate (by weight) are dissolved in ten ounces of glycerine and boiling water sufficient to make a Winchester quart (by measure). The glycerine must be added slowly while the solution is hot and stirred gently or the salt precipitates on cooling. The solution is then sterilized in an autoclave and is ready for use.

Application as a Dressing.—In recent injuries the wound is

freely opened up, any foreign body, bullet, portion of shell, clothing, etc., is removed and the whole wounded surface is swabbed over with pure carbolic acid. In the case of fractures, the ends of the bone are treated in the same way, and free fragments of bone are removed. The wound is gently packed for twenty-four hours with gauze wrung out of carbolic lotion (1 in 20) and antiseptic wool applied as an outer dressing. At the end of this time, the wound is dressed, the gauze plug is removed, the wound is syringed out with magnesium sulphate solution of the strength indicated above, no swabbing of the wound is done and the wound is loosely packed with sterile lint taken out of the magnesium sulphate solution in which it is constantly kept. The strips of lint used are narrow (from half inch to one inch wide) so that the solution with which they are saturated comes in contact with all parts of the wound surface. A double layer of lint, wet with the solution, covers the whole of the surface wound. This is covered with a piece of jaconet and then cotton wool, the whole dressing being fixed loosely by a bandage. In the case of wounds of a later date, where sepsis and suppuration are fully established, the treatment by carbolic acid is omitted and magnesium sulphate solution is commenced at once. Dressings even in the worst cases are changed only at twelve hours intervals thus saving a patient much discomfort and trouble. The effect on the wound is very striking. In two or three days pus has almost disappeared, sloughs begin to separate, and the whole surface presents a bright red colour. The granulations never become flabby or œdematous, but instead a firm, vascular, healing wound is seen. Scratching the surface of the wound with a probe hardly disturbs the vascular granulations. The growth of epithelium from the edges of the wound proceeds vigorously and the treatment may be continued with advantage until the entire wound is healed. The resulting scar is firm and elastic and seldom tends to contract or to become painful.

Pte. A. B. was admitted into the Red Cross Hospital on March 22, 1915, suffering from an injury to the left leg. A posterior splint was applied to the leg during transport from France and on removing the dressings, pus poured from a wound in the back of the leg. A drainage tube passed under a bridge of skin and muscles in the middle of the calf, and a large gaping wound was present on the inner side of the calf muscles. He stated that a large piece of shell had passed right through the calf of the leg. No fracture could be found on examination or by X-rays.

Treatment.—The leg was slung on a cradle, the drainage tube

removed and the wound lightly packed with lint wrung out of magnesium sulphate solution. Progress made was very rapid, the wound soon healed and on April 30 he was discharged to a convalescent home with the wound quite healed and a mobile scar.

In some cases where the dressing has extended over the skin surrounding the wound, pustules appear from some irritating effect of the solution on the skin glands. To prevent this occurring the lint should not much more than cover the wound, or the neighbouring skin may be smeared with oleate of zinc ointment.

We tried in a series of cases diluting the solution a half, a quarter, and an eighth, and also substituting magnesium chloride in half the strength of sulphate (1 in 4); but on every occasion on which this was done pus again appeared in the wounds, granulations became flabby, weak and œdematous and bled too freely when touched. On returning to the stronger solution the wound again resumed a healthy appearance. The laboratory experiments by Lieutenant Tulloch largely explain the results of the clinical findings.

Constitutional symptoms seldom occur, probably owing to the fact that owing to the density of the granulations absorption does not take place. There is therefore no general disturbance of health. There is an absence of lymphatic and glandular infection and secondary abscesses have been in my experience unknown.

The effect in the majority of compound fractures is very quickly manifest. Pus rapidly disappears and the amount of necrosis in comminuted cases appears, as would be expected when infection is diminished, to be materially less.

In the wards about a Winchester quart of the solution is used every day in dressing about forty cases, and the cheapness of the lotion, with the infrequent dressings required, means no inconsiderable saving of expense.

Investigation of Magnesium Sulphate Solution with a View to its Employment in the Treatment of Septic Wounds.

(By Lieutenant W. J. Tulloch.)

Solutions of salts are at present so extensively used in the treatment of wounds that a number of problems presented by their employment are worthy of consideration.

So far the salt that has naturally received most attention in this connexion—thanks to the brilliant work of Sir A. E. Wright—has been sodium chloride, presumably because it is the predominant electrolyte of the tissues and its use as an "osmotic cleanser" is therefore regarded as free from danger.

While the value of NaCl as an inducer of "lymph lavage" cannot be gainsaid, it appears questionable if it is the best "osmosing" solution that could be made use of, for, in addition to the power of producing lymph flow by osmosis, certain other properties of the solutions employed have to be considered. Among these may be cited the following :—

(1) Its influence on the proteolytic action of pus.

(2) The extent to which the salt is absorbed by granulations.

(3) The effect of the salt on phagocytosis.

(4) The type of granulation produced.

(5) The influence of the salt on the bacterial flora of the wound.

Of these, the second, third and fourth are interdependent and their relation to a wound infection is of supreme importance, in that a barrier of compact healthy granulations is the best safeguard that the tissues can have against bacterial invasion, with its sequelæ of secondary abscess formation and spreading infection of the wound area.

If the salt used for producing osmosis be absorbed the danger of causing the granulations to become soft and puffy is not negligible.

Among the less readily absorbed salts $MgSO_4$ is prominent and the following experiments have been undertaken with a view to determining its properties in respect of surgical therapeutics.

Method Employed for Standardizing the Solutions Used.

The basis upon which the solutions employed were standardized is as follows :—

The concentration of magnesium sulphate employed by Mr. A. E. Morison in his wards was considered as unity, and a series of dilutions of salts—NaCl, $MgCl_2$, Na_2SO_4—of equiosmotic value was prepared. The equiosmotic power in each case was arrived at by the method of Hamburger [1]. It was found that a solution of approximately twelve per cent NaCl had to be diluted with the same bulk of water as had the solution of $MgSO_4$ employed to render both isotonic with human blood corpuscles.

The solutions of the salts were made in series, halving the concentration in each successive tube so that in a series of six tubes—"a" to "f"—of the $MgSO_4$ solution, we had "a" equal to 1, "b" = $\frac{1}{2}$, "c" = $\frac{1}{4}$, "d" = $\frac{1}{8}$, "e" = $\frac{1}{16}$ and "f" = $\frac{1}{32}$ of the strength of solution which had been employed in wound treatment, while in the NaCl series "a" was equal to 4, "b" to 2, "c" to 1, "d" to $\frac{1}{2}$, "e" to $\frac{1}{4}$, and "f" to $\frac{1}{8}$ of the strength of Wright's

hypertonic saline, assuming this to be a three per cent solution of salt.

In each experiment, corresponding series of Na_2SO_4 and $MgCl_2$ were also examined, the object being to determine if possible the action of the ions Mg, Cl, Na, and SO_4 as distinct from the molecules of $MgSO_4$ and NaCl.

(1) *Experiments relating to the Influence of Salts on the Proteolytic Action of Pus.*

It is known that pus has proteolytic properties, and if left in contact with a wound interferes to some extent with the growth of new tissue. This interference however, is of but little import where highly vascular tissue is concerned for such tissue contains sufficient serum to inhibit this proteolytic activity, and largely to negative its ill effect. Ordinarily proteolysis is of importance because it interferes with epithelialization, when the avascular and therefore not antiproteolytic epithelium experiences difficulty in growing in presence of pus.

If then the magnesium sulphate dressing is to be used as a fomentation, and unless it can be so used it has little advantage over salt, it must interfere with this proteolytic activity of the wound exudate.

The first series of tests was carried out with a view to investigation of this point.

Series No. 1.

Experiment No. 1. *Influence of the Salts on Tryptic Digestion.*—Before carrying out the experiment the dose of trypsin necessary for complete digestion—in one hour at 50° C.—of that quantity of protein suspension employed in the tests was determined, the reactions being carried out in 0·9 per cent NaCl plus 0·5 per cent Na_2CO_3.

Using twice the dose of trypsin as ascertained by the above procedure, and working under the same conditions in the presence of varying dilutions of the salts, the following result was obtained :—

	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$
$MgSO_4$ (as used in the wards)	—	—	—	—	—
NaCl (equiosmotic with $MgSO_4$)	p	x	x	x	x
$MgCl_2$ (equiosmotic with $MgSO_4$)	—	—	—	—	—
Na_2SO_4 (equiosmotic with $MgSO_4$)	p	x	x	x	x

x = complete digestion of the protein.
— = no digestion.
p = partial digestion.

These results proved that the Mg salts markedly interfere with the action of trypsin. This seems to depend on the Mg ion, and it is not improbable that other divalent cations would have a similar effect. This point, however, has not been investigated.

The experiment is suggestive, but is open to the obvious criticism that trypsin is not pus and the mechanism of proteolysis by pus may well be different from that of trypsin proteolysis, just as the mechanism of peptic digestion differs from that of tryptic digestion.

Series No. 2.

Effect of the Salts on Leucocyte Ferments.—In view of the above criticism other methods were devised to show the influence of the salts on the ferment activity of leucocytes.

A few preliminary tests were made employing a technique similar to that of the Abderhalden test, but owing to the supply of ninhydrin running short sufficient observations could not be made to permit of any conclusions being drawn from the work done.

It was then decided to make use of the method described by Wright for investigating the "antitryptic" action of serum in further examination of the problem.

A thirty per cent peptone gelatine standardized to plus 20 of Eyre's scale was used as the material to be digested. This concentration of gelatine was chosen so that with the addition of an equal volume of electrolyte to be examined the strength of the gelatine equalled fifteen per cent (plus ten of Eyre's scale).

The obtaining of sufficient leucocytes free from serum was a problem that presented some difficulty, and after a few preliminary examinations it was decided to employ washed clot as the source of the leucocyte ferments.

Blood, obtained with care to prevent gross contamination was set to coagulate overnight, the clot was then washed in sterile water, forced through a fine sieve into a large volume of sterile water—temperature about 40° C.—contained in wash-bottle flask. Before proceeding to wash the clot the total weight of blood was determined and a known fraction of this was treated in the same way, its residue after washing being weighed in order to estimate the weight of washed clot obtained from the blood.

The fluid in the flask was renewed several times and the flask was shaken until the clot became almost colourless. The water was then run off and the deposit of washed clot was smeared over the interior of the flask by means of a sterile glass spatula; the flask was then inverted and the excess of water allowed to drain off.

For each 0·5 gramme of washed and drained clot in the flask one cubic centimetre of thirty per cent gelatine was added and the whole well mixed. This constituted a "clot-gelatine mixture" which could be used in this series of experiments, and of this mixture 1·5 cubic centimetres were added by means of a wide-mouthed pipette to an equal volume of the solutions of salts to be investigated.

Experiment A.—In this experiment human clot was used, the above quantities of the reagents being employed. The clot was obtained from the pooled blood of cases examined by the Wassermann test, all the blood samples employed having given negative reactions.

After mixing the reagents the tubes were incubated at 50° C. for twenty-four hours, removed from the incubator, and then placed in water at 7° C. for two hours to harden the gelatine before readings of the experiment were taken.

The following result was obtained :—

	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$
$MgSO_4$	x	x	x	x	x	x
Na_2SO_4	x	x	x	x	x	x
$MgCl_2$	—	?	x	x	x	x
NaCl	—	—	?	x	x	x
At forty-eight hours :—						
$MgSO_4$	x	x	x	x	x	x
Na_2SO_4	x	x	x	x	x	x
$MgCl_2$	—	—	?	x	x	x
NaCl	—	—	—	?	x	x
At seventy-two hours:—						
$MgSO_4$	x	x	x	x	x	x
Na_2SO_4	x	x	x	x	x	x
$MgCl_2$	—	—	?	?	x	x
NaCl	—	—	—	?	x	x
At ninety-six hours :—						
$MgSO_4$	x	x	x	x	x	x
Na_2SO_4	—	—	—	?	x	x
$MgCl_2$	—	—	—	?	x	x
NaCl	—	—	—	?	x	x

x = gelatine on cooling still sets.
— = gelatine liquefied.
? = result not satisfactory, or no definite result.

The above results suggest that of the salts examined, $MgSO_4$ only has an inhibitory influence in the conditions under which the experiment was performed on the liquefaction of gelatine by leuco-

cyte ferments, but the evidence, while suggestive, is not conclusive, for it may be that the result depends largely upon the influence of the electrolytes themselves upon the gelatine. The fact that liquefaction has occurred only in the presence of the higher concentrations of the salts points to this, although controlled experiments (*vide* Experiment B) suggest that some factor other than the electrolytes must be considered as taking a part in the liquefaction.

That salts alone have a marked effect on gelatine is well known. "Saline digestion of gelatine" is a phenomenon long recognized, and it would appear from the experiment under consideration that the converse may occur, both Na_2SO_4 and $MgSO_4$ tending to harden gelatine. This hardening effect masks the digestion in presence of Na_2SO_4 until incubation has been in progress for three to four days.

It will be noted that in the above experiment the highest concentration of the salts are equal to six per cent NaCl, not twelve per cent as in the experiments of the other series, and in the trypsin experiment first described. The concentrations were reduced so that the effect of the salts alone upon the gelatine would vitiate the results to a less extent than would have been the case were the highest concentrations used. Strong solutions of NaCl markedly interfere with the setting of gelatine, liquefying it in neutral solution, and precipitating it in presence of acid.

It is interesting to note in this connexion that Rubinstein [2], investigating the "antipeptic" influence of blood salts, found that Na_2SO_4 and NaCl had no "antipeptic" properties, while the phosphates of magnesium and calcium were very active, the former being five times as active in inhibiting peptic digestion as the latter. It is only fair to relate in this connexion that the findings of Grutzner and Pfleiderer do not agree with those of Rubinstein in respect of the influence of Na_2SO_4 on peptic digestion.

Experiment B.—As the results of Experiment A of this series were open to criticism on the ground that the test was performed at 50° C., another series was set up using the same technique, but substituting washed sheep clot for washed human clot and incubating at 37° C.

Here greater difficulty was experienced in obtaining clot free from gross contamination than was the case when human clot was employed, and the technique had to be so modified that growth of contaminating organisms could be inhibited at 37° C. This was done by incubating the tubes in a metal box, the floor of which was covered with cotton wool on which was sprinkled ten cubic

centimetres of chloroform, after which the lid was sealed down with plasticine. Tubes of broth sown with *Bacillus coli*, *B. subtilis*, and *Staphylococcus aureus* were incubated along with the gelatine tubes to ensure that the chloroform vapour employed sufficed to prevent the growth of these organisms.

Employing this method the following results were obtained, the experiments with the clot present being controlled by a similar series of tubes containing no clot.

After twenty-four hours' incubation at 37° C.:—

	Without clot						With clot					
	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$
$MgSO_4$	x	x	x	x	x	x	x	x	x	x	x	x
Na_2SO_4	x	x	x	x	x	x	x	x	x	x	x	x
$NaCl$	x	x	x	x	x	x	x	x	x	x	x	x
$MgCl_2$	x	x	x	x	x	x	—	p	x	x	x	x

After forty-eight hours' incubation:—

	Without clot						With clot					
	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$
$MgSO_4$	x	x	x	x	x	x	x	x	x	x	x	x
Na_2SO_4	x	x	x	x	x	x	x	x	x	x	x	x
$NaCl$	x	x	x	x	x	x	—	—	x	x	x	x
$MgCl_2$	x	x	x	x	x	x	—	—	x	x	x	x

After seventy-two hours' incubation:—

	Without clot						With clot					
	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$
$MgSO_4$	x	x	x	x	x	x	x	x	x	x	x	x
Na_2SO_4	x	x	x	x	x	x	x	x	x	x	x	x
$NaCl$	x	x	x	x	x	x	—	—	—	p	x	x
$MgCl_2$	x	x	x	x	x	x	—	—	p	x	x	x

After ninety-six hours' incubation:—

	Without clot						With clot					
	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$
$MgSO_4$	x	x	x	x	x	x	x	x	x	x	p	—
Na_2SO_4	x	x	x	x	x	x	—	—	—	—	—	—
$NaCl$	x	x	x	x	x	x	—	—	—	—	—	x
$MgCl_2$	x	x	x	x	x	x	—	—	—	p	x	x

x = gelatine solidified.
— = gelatine not solidified.
p = gelatine fluid, but markedly viscous.

The observations in this experiment were made under the same conditions as in the previous test and the above result (after four

days' incubation) was verified by allowing the tubes to set overnight. The result was the same as that noted, but in the Na_2SO_4 series "with clot," the liquefied gelatine was more viscous than in the case of the chlorides.

This experiment was repeated several times, both at 37° C. and 50° C., and the results, while not absolutely constant, all showed the following points in common:—

(*a*) The controls did not show liquefaction.

(*b*) In presence of the higher concentrations of the chlorides the gelatine was liquefied if clot was present.

(*c*) The Na_2SO_4 series was always difficult of interpretation, there being no liquefaction till the third day.

(*d*) Liquefaction, unless exceptionally, did not occur in presence of $MgSO_4$, and then only in presence of the lowest concentration examined.

These results suggest that $MgSO_4$ has an inhibitory influence upon the digestion of gelatine by blood clot—a property not shared by the other salts examined—but the conditions of the reagents in the tubes in these experiments are so complex that a slight alteration in the conditions of the test might lead to very different results.

I therefore hesitate to draw any definite conclusions from these experiments even though, as indicated above, the findings are fairly constant, and I believe that a more satisfactory indication of the antiproteolytic properties of $MgSO_4$ is to be found by observation of the comparative rates of epithelialization of wounds treated by $MgSO_4$ and hypertonic salt.

(2) *Note Concerning Absorption of* $MgSO_4$.

Although we cannot offer definite evidence to the effect that $MgSO_4$ is not absorbed by granulation tissue we have good grounds for believing that absorption of this salt, if it occurs at all, is so slight as to be almost negligible.

Physical chemistry suggests this. Hober [3] showed that Mg ion was the slowest in passing through animal membranes—such as intestine—of all the cations he examined. Na ion passed through much more rapidly.

He also found that of the anions Cl was the most, and SO_4 the least absorbable of the ions investigated.

Pharmacology, too, indicates that the action of $MgSO_4$, in the intestine at least, is mainly osmotic, the salt not being absorbed.

As definite experimental evidence on the point under considera-

tion is lacking, I shall not further elaborate this section of the work, but desire to call attention to the following points.

The granulations in wounds treated with $MgSO_4$ do not tend to become flabby and there is little pain associated with the treatment. Both these facts suggest that absorption does not take place.

The employment of NaCl in comparison causes considerable pain, and of a number of cases thus treated the granulations tended to become redundant.

As illustration of this point I may cite the experience of Major D'Oyly Grange, Surgical Registrar, Northumberland War Hospital, who finds that not infrequently treatment by continuous irrigation with three to five per cent NaCl results in the granulation tissue becoming œdematous. The œdema may be transient and is soon reduced when the three per cent NaCl solution is replaced by 0·75 per cent.

This œdema probably arises thus: Salt is absorbed by the superficial granulations which then become "hypertonic" to the underlying tissues; should the fluid from the deeper tissues pass at a greater rate to these granulations than the fluid is withdrawn from them to the solution bathing the wound surface, a condition of water stasis will ensue. Though clinical evidence indicates that in most cases the stasis is but temporary and an equilibrium is soon established, nevertheless NaCl is being absorbed all the time that NaCl dressings or irrigation fluids are in contact with wounds. I think that this is a point of great importance, for largely upon it depends our thesis that $MgSO_4$ presents advantages over NaCl as an "osmotic cleanser" of wounds. *Not being absorbed it in no way interferes with the vital activities of the cells of granulation tissue.*

We have used $MgCl_2$ in a few cases but this salt was found to answer less satisfactorily than $MgSO_4$. I believe that it is less satisfactory because it is more readily absorbed than $MgSO_4$.

(3) *Influence of Salts on Phagocytosis.*

It is my belief that $MgSO_4$ has a distinct advantage over NaCl, as, by virtue of its not being absorbed, it will not interfere with the phagocytic activity of living leucocytes.

It is well known that phagocytosis is not so active in presence of hypertonic solutions of NaCl as it is in isotonic saline, and in employing NaCl, which is readily absorbed, there is a risk of interfering with the phagocytic power of the leucocytes in the granulations.

Our aim should be to obtain a dressing which would not interfere with the digestive and phagocytic activities of the white cells so

long as these are constituents of living tissue, but one which will inhibit their proteolytic power when the leucocytes escape and become part of the purulent discharge.

The following opsonic estimations show the effect of the salts under consideration on the power of phagocytosis.

Opsonic tests were set up as follows :—

(1) Tube "a"—Equal volumes of *Staphylococcus aureus* emulsion, washed leucocyte suspension, serum, and twelve per cent salt were mixed and incubated at 37° C. for fifteen minutes, a slide was then prepared in the usual way and a count of organisms in 100 leucocytes was made. The staphylococcus and leucocyte emulsions were both prepared in 0·85 per cent NaCl. In this tube then the NaCl = 3·65 per cent.

(2) Tube "b"—Prepared in the same way but the twelve per cent NaCl was replaced by six per cent. The NaCl concentration = 2·06 per cent.

(3) Tube "c"—As before, but three per cent NaCl used in place of twelve per cent NaCl concentration = 1·31 per cent.

(4) Tube "d"—As before, but 1·5 per cent NaCl used = NaCl concentration = 0·93 per cent.

(5) Tube "e"—Used 0·75 per cent—Concentration of NaCl = 0·75 per cent.

(6) Tube "f"—Used 0·375 NaCl—Concentration of NaCl = 0·63 per cent.

A similar series of tubes each containing $MgSO_4$ in place of the NaCl—12 per cent, 6 per cent, 3 per cent, 1·5 per cent, 0·75 per cent, 0·375 per cent—was set up and dealt with in exactly the same way as were the NaCl series, for comparison with these.

Employing this technique the following results were obtained, the numbers indicating the cocci phagocytosed per leucocyte in the count of 100 cells :—

NaCl Per cent			$MgSO_4$ Per cent		
"a," 3·65,	ingested organisms	= 0·04 ..	"a," equiosmotic with 3·65 NaCl,	ingested organisms	= 0·00.
"b," 2·06,	,, ,,	= 0·26 ..	"b," ,, ,, 2·06	,, ,, ,,	= 0·18.
"c," 1·31,	,, ,,	= 1·2 ..	"c," ,, ,, 1·31	,, ,, ,,	= 0·7.
"d," 0·93,	,, ,,	= 5·7 ..	"d," ,, ,, 0·93	,, ,, ,,	= 5·1.
"e," 0·75,	,, ,,	= 9·36 ..	"e," ,, ,, 0·75	,, ,, ,,	= 8·5.
"f," 0·63,	,, ,,	= 13·3 ..	"f," ,, ,, 0·63	,, ,, ,,	= 14·1.

These results are interesting because they show that even a moderate increase in the tonicity of the fluids causes some inhibition of phagocytosis.

I was surprised however, that $MgSO_4$ did not cause more marked

inhibition than was the case, for it appeared not improbable that the Mg ion would exert a toxic influence, apart from the influence of increased tonicity, in respect of the phagocytic process.

The point is only of minor import however, as the non-absorption of $MgSO_4$ would rule out any deleterious effect caused through this mechanism.

(4) *Type of Granulation Produced.*

The granulations resulting after the $MgSO_4$ treatment are flat, compact, and vascular, making a formidable defence against organismal invasion of the surrounding tissues. These characteristics must be associated with the absence of absorption of the salt for reasons indicated in the preceding section.

It is also important to remember that, being compact throughout the course of treatment almost from its inception, the granulations form a good scar, which is remarkably mobile, and does not tend to contract so much as an ordinary scar of a similar size would certainly do.

(5) *The Effect of $MgSO_4$ and Solutions of other Salts (Equiosmotic) with $MgSO_4$ Solutions on the Growth of Organisms Infecting Wounds.*

A final series of experiments was carried out to determine the influence of NaCl, $MgSO_4$, Na_2SO_4, and $MgCl_2$, upon growth of the organisms commonly found infecting wounds.

Broth containing 2 per cent peptone was used to dilute the solutions which were made equimolecular with 12 per cent, 6 per cent, 3 per cent, 1·5 per cent, 0·75 per cent, and 0·375 per cent NaCl in each series. To each of the tubes containing these concentrations of electrolytes there was added one cubic centimetre (equal volume) of broth heavily inoculated with the organism to be examined. The tubes were then incubated for twenty-four hours at 37° C., and examined both macroscopically and by film preparations.

Experiment A.—Examining in this way a streptococcus of the "pyogenes" type, isolated recently from a wound, the results shown in the table were obtained.

These results show that both $MgCl_2$ and $MgSO_4$ exert a restraining influence on the growth of streptococcus greater than do NaCl and Na_2SO_4. This effect appears to depend on the Mg ion, for experiments in which the gradation of concentrations was less abrupt showed that $MgCl_2$ was more active than $MgSO_4$—

a result that one would expect in view of the more marked dissociation of the chloride.

NaCl concentration	NaCl	$MgSO_4$	Na_2SO_4	$MgCl_2$
6 per cent	No growth ..	No growth ..	No growth ..	No growth.
3 ,,	Good growth; the organisms show normal appearance	,, ,, ..	Good growth; organisms show normal appearance	,, ,,
1·5 ,,	Good growth; normal	Fair growth; great variety in shape and in staining properties	Good growth; normal	Slight growth; great variety in shape and staining properties.
0·75 ,,	Good growth; normal	Good growth; normal	Good growth; normal	Good growth; normal.
0 375 ,,	Good growth; normal	Good growth; normal	Good growth; normal	Good growth; normal.

In the above experiment, and in those which follow, the highest concentration of the salts is equal to six per cent, the reduction in concentration being due to the addition of the inoculated broth to the dilutions of the salt.

Experiment B.—A similar experiment was carried out with staphylococci, and here none of the salts could be shown to interfere with growth of the organisms.

Experiment C.—In this experiment the organism investigated was *B. coli,* and the results were peculiar in that very marked involution of the organism occurred in presence of the Mg salts, while, with the higher concentrations of all the salts, the organism developed as a streptobacillus. The involuted forms in the tubes containing the higher concentrations of the Mg salts were very bizarre in appearance, being as much as 30 μ in length and shaped liked Higginson enema syringes.

The table on next page shows the results of the examination of *B. coli*.

Here, again, is evidence of the inhibitory power of the Mg ion, as shown by the marked inhibition of the growth of *B coli* in presence of Mg salts, and notably in presence of the easily dissociated chloride.

Experiment D.—*B. pyocyaneus* was examined also, but growth took place in the presence of these concentrations of the salts that were tested in this series. The highest concentration of $MgCl_2$ and $MgSO_4$ caused some involution of the bacilli. This

slight inhibitory action of Mg, in respect of *B. pyocyaneus*, could be clearly demonstrated with solutions of double strength of those employed in the experiments of this series.

NaCl concentration	NaCl	$MgSO_4$	Na_2SO_4	$MgCl_2$
6 per cent	Poor growth; the bacilli are very large and are arranged in chain formation	Slight growth; organisms are extremely large; are all spindle-shaped, and show great irregularity of staining	Good growth, large in size; show marked chain formation.	No growth.
3 ,,	Organisms large; arranged in short chains	Fair growth; chain formation; spindle forms in large numbers; stain irregular	Good growth; organisms are larger than normal, but show no chain formation	Very slight growth; all the bacilli are spindle-shaped, and very large.
1·5 ,,	Normal ..	Organisms are large, and show marked chain formation	Normal ..	Chain formation; irregular staining; some spindle forms.
0·75 ,,	,, ..	Normal	,, ..	Bacilli are large, and show chain formation.
0·375 ,,	,, ..	,, ...	,, ..	Normal.

Experiments E. and F.—Two saccharose fermenting diphtheroids obtained from wounds were investigated in the same way, but no inhibitory action was observable.

Experiment G.—I was so struck with the examination of streptococcus (Experiment A of this series) that I decided to inoculate a series of tubes of the four salts with a mixed culture of streptococcus and *B. pyocyaneus*.

A tube containing twenty cubic centimetres of nutrient broth was heavily inoculated with streptococci (one cubic centimetre of a twenty-four hour broth culture), and lightly with *B. pyocyaneus* (a very small loopful of a twenty-four hours' broth culture). The broth sown thus with the two organisms was distributed into the series of dilutions of the four salts, and the tubes examined after twenty-four hours, and again after forty-eight hours' incubation at 37° C.

In the $MgSO_4$ and $MgCl_2$ series only pyocyaneus grew in the two highest concentrations and streptococci were very few in number in the tube containing the third highest concentration of these salts, while in the corresponding series of sodium salts the

streptococci were numerous in the second higher concentration and a few could be demonstrated even in the highest concentration.

This aspect of the work was of so much interest that it was decided to make some direct examinations of wound exudates by means of Wright's lymph leeches. Two of these examinations—which were repeated to exclude technical error—are so striking that I feel they are worthy of special note.

(1) Two Wright lymph leeches were applied to a granulating surface known to contain streptococci, and before application each was half filled with sterile solution—one with $MgSO_4$ as used by Mr. Morison, the other with twelve per cent NaCl. Both leeches were left under the dressing for a period of four hours. On removing the dressings the leeches were transferred to sterile test tubes and incubated from 6 p.m. to 9 a.m. The fluid from each was pipetted into broth which was then incubated at 37° C. for twenty-four hours. The broth inoculated with the contents of the "salt leech" gave a copious growth of streptococci, that inoculated with the contents of the "$MgSO_4$ leech" gave no growth.

(2) Similar experiments carried out on wounds with mixed infection with streptococci and pyocyaneus gave corresponding results. Both streptococcus and pyocyaneus appeared in cultures from the "salt leeches," pyocyaneus alone in cultures from the "$MgSO_4$ leeches."

Conclusions.

(1) From the first series of experiments it appears that $MgSO_4$ exhibits to a greater degree than do the other salts investigated the desirable property of interfering with the digestive activity of pus.

This statement is made with reservation as the experimental methods that one is forced to employ are open to certain criticisms, and I suggest that the rate of epithelialization of the wounds treated would give a truer index of the property than experimental investigation does.

(2) $MgSO_4$ has not so markedly inhibitory an action on phagocytosis as one would expect and, therefore, even if it be absorbed to a slight extent, it would not have a deleterious influence on the process, while salt, being more readily absorbed, might well interfere with this function of the leucocytes.

(3) Experimental work in physical chemistry and pharmacology points to $MgSO_4$ as the least absorbable of the readily soluble salts,

while clinical evidence—absence of pain, etc.—points in the same direction.

(4) By virtue of the non-absorption of $MgSO_4$ the granulations produced are more compact than when a more readily absorbable salt is employed.

(5) The Mg ion has a markedly inhibitory action on the growth of streptococci and *B. coli*, and a slightly inhibitory effect on the growth of pyocyaneus. It has, however, no easily demonstrable influence in the concentrations examined, on the growth of staphylococci, or on the diphtheroids investigated.

Incorporating these conclusions in a final note one may say that it appears from the above findings that $MgSO_4$ would be the most satisfactory salt to employ for the production of "lymph lavage" and its properties indicate that it might be used satisfactorily and safely in the form of a fomentation.

I lay stress on this last point, for if the fomentations only require renewal twice daily the dangers of manipulation are much reduced and the work of the wards is lightened.

We wish to point out that we do not suggest that $MgSO_4$ solutions ought to be employed for a first dressing for fresh wounds. These dressings we think should be strongly antiseptic in character, their function being prophylactic rather than curative. It is as a curative dressing in the succeeding phase that we suggest $MgSO_4$ might be made use of with great advantage.

For permission to publish this paper we are indebted to Colonel G. G. Adams, A.M.S., Commandant of the Northumberland War Hospital.

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CHANGES IN THE AGGLUTINABILITY, FERMENTATION REACTIONS AND ABSORPTIVE CAPACITIES OF THE MENINGOCOCCUS DURING THE ACUTE ATTACK.

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(*Report to the Medical Research Committee.*)

DURING the epidemic of 1914-15 it was reported that some of the cases were treated advantageously with that type of anti-serum which showed the highest agglutinative power for the meningococcus isolated from the first lot of cerebrospinal fluid obtained. In view of the experiences then gained and the preparation of special anti-sera from the strains of meningococci yielded by the last outbreak, it seemed worth while to examine our 1915-16 cases day by day in order to form some idea of the behaviour of the meningococcus under the influence of the newer conditions of treatment. As only a certain number of the patients in each district offer suitable opportunities for this form of observation, we venture to record our findings at this early date in the hope that it may prompt elsewhere some critical investigation of our results.

The plan of work in each case was as follows:—

(1) The routine microscopical and cultural examinations of lumbar puncture fluids, blood, urine and nasopharynx.

(2) Agglutinin estimations of blood and cerebrospinal fluids

- (*a*) With cerebrospinal coccus isolated same day.
- (*b*) With cerebrospinal cocci isolated on previous days.
- (*c*) With nasopharyngeal cocci isolated on same day.
- (*d*) With nasopharyngeal cocci isolated on previous days.
- (*e*) With stock strains of meningococci, representing Types I, II, and III, and in one case No. IV also.

(3) Determination of the agglutinability of cocci isolated from cerebrospinal fluid and nasopharynx with monovalent sera obtained with meningococci, Types I, II, and III.

(4) Estimation of the agglutinable capacities of the same cocci with therapeutic sera—Army, Lister and Dopter. These were each from one lot and were preserved in sealed capsules.

(5) Absorption experiments with the cocci isolated and homologous and standard sera.

(6) Preparation and testing of immune sera prepared for each coccus.

METHODS.

Conscious of the many difficulties and possible fallacies connected with this type of work, we decided that it was best to adhere in every detail to the procedures recommended by the Central Cerebrospinal Laboratory at Millbank. In this way, whatever results were obtained they would be comparable with the work done in other laboratories and would be presented in a form available for critical observations.

Consequently, cultures were made on the Army trypagar with superficial smearings of fresh blood and glucose. The agglutinating sera and stock cocci were those supplied by the Central Laboratory and their control normal sera and standard sera were put up with each experiment. Absorptions were carried out on the lines suggested by Gordon, the centrifuge and number of revolutions, temperature, density of suspensions, tubes and apparatus being unvaried throughout.

For nasopharyngeal isolations, West's swabs were always used, plates were sown at the time the swab was taken and incubated at once. Cerebrospinal fluid was examined within a short time after removal and plates were incubated for twenty-four hours with the addition of ascitic glucose in order to provide against any failure of primary platings. Subcultures were kept up on blood agar and egg media.

Bacterial emulsions were prepared from the first subcultures according to the method used by Gordon, and large quantities were made so as to provide against the dying out of the subcultures. We did not make the suspensions otherwise than by heating, although some observations had convinced us that it is in this part of the procedure that experimental error has the greater sway. To follow one's own choice of method would militate against the general work now in hand. At the same time we feel that it is necessary to point to the need for additional work on the prepara-

tion of emulsions in order to approach more nearly the precise chemical changes which the tissue cells and fluids have to meet during the course of an attack.

Fermentation reactions and agglutinations were carried out and the results recorded on present-day lines.

Blood serum was drawn off from the clot and kept in the cold in sealed capsules. Cerebrospinal fluid was centrifugalized and the clear supernatant layers placed in the cold.

The agglutinations were macroscopical and conducted at 55° C. in a moist oven for twenty-four hours, but were examined at the end of twelve hours. After a further reading at twenty-four hours, they were allowed to stand at room temperature for another twenty-four hours and read once more. It has been our experience, that when meningococci are agglutinated by immune sera the effect is nearly always evident in the first twelve hours. The end titre recorded was that which yielded good clumping with clarity or definite decreased turbidity of the fluid. To keep the work within compass, the dilutions did not extend beyond 1 in 500 for stock cocci and sera, although for therapeutic sera, blood and cerebrospinal fluids from the cases, they were taken up to 1 in 2,000.

The amount of work involved in these procedures was heavy and proved almost more than could be managed in a military laboratory occupied with routine examinations. We were compelled, therefore, to defer the immunity questions to a later date. This defect in our results we admit with regret, but it is perhaps better to invite criticism upon what we have already done and to ask for confirmation of our findings from those who may meet with cases which permit of similar observations, than to delay any mention for a considerable period. The lack of monovalent sera was compensated for by the use of the standard sera and cocci issued by the Central Cerebrospinal Fever Laboratory. The work was carried out with one lot set aside for this purpose. The experiments were repeated in one case with a second set and the appended comparison forms a tribute to the care exercised by those in charge of the standardization department at Millbank.

It may prove convenient if we state first the several cases in detail and then discuss the indications they have afforded.

Case A.

Man, aged 21. Sudden onset with headache, rigidity, postive Kernig, unconsciousness and temperature. Lumbar puncture was performed the same day. For some time he progressed favourably, but death occurred on the twentieth day. We have much pleasure

CASE A.

Fluid	Cerebrospinal Fluid—Films and Cultures— Type of Coccus (Agglutination)	Film P.	Film E.	Film L.	Film Cocci	Film Blood	Reactions Glucose	Reactions Mannose	Reactions Saccharose	Nasopharynx— Type of Coccus (Agglutination)	Reactions Glucose	Reactions Mannose	Reactions Saccharose	
1st day, cloudy	II	80	15	5	+	o	+ A_5	–	–	II	A_5	–	–	Before Army serum injected.
7th day, cloudy	II	79	14	7	+ phag.	o	+ NoA	–	–	II	+ NoA	–	–	Army serum injected daily.
11th day, cloudy	II	80	15	5	None	o	o	o	o	II	+ NoA	–	–	
17th day, yellow	o	40	20	40	None	o	o	o	o	o	o	o	o	
20th day, death	..			..				..		..		..		..

AGGLUTINATIONS. CASE A.

(The end titres are only given.)

	Stock Cocci Strains I Titre	II Titre	III Titre	IV	Patient's own Meningococcus isolated from— Cerebrospinal Fluid 1st day coccus Titre	Cerebrospinal Fluid 7th day coccus Titre	Nasopharynx 1st day coccus Titre	Nasopharynx 7th day coccus Titre	
Cerebro-spinal Fluid—									
1st day	–	50	50		50	–	50	–	Before Army serum injected.
7th day	–	12	12		25	50	12	125	Army antiserum injected daily.
11th day	–	50	12		–	50	–	50	
17th day	–	–	–		Under 2	Under 2	Under 2	Under 2	
20th day	Death	..	..		..	..	..	..	..
Blood—									
1st day	–	10	–		50	–	250	–	Before Army serum injected.
7th day	–	500	500		750	1,250	250	1,250	Army antiserum injected daily.
11th day	–	250	250		–	–	1,250	1,250	
17th day	–	Under 25	Under 25		Under 25	Under 25	Under 25	Under 25	
20th day	Death	..	..		..	..	..	..	..
Urine	o	o	o		o	o	o	o	..
Dopter serum	o	50	o	50	Under 12	Under 25	Under 25	Under 25	..
Army Lister serum	500	50	50	750	12	125	125	125	..

— and o = under 1/50 titre.

EXHAUSTION OF STANDARD TYPE SERA. CASE A.

		End Titre before Exhaustion—				End Titre after Exhaustion—			End Titre of Exhausted Sera— With Corresponding Standard Cocci			Agglutinins absorbed
		Normal serum	Type serum I	Type serum II	Type serum III	Type serum I	Type serum II	Type serum III	Type serum I	Type serum II	Type serum III	Per cent
Stock cocci		o	500	500	500				o	o	o	
Cerebrospinal fluid cocci ..	1st day	o ..	o ..	500 ..	o	o ..	o ..	o	500 ..	125 ..	500	75
	7th day	o ..	o ..	500 ..	o	o ..	o ..	o	500 ..	125 ..	500	75
N.-P. S. cocci	1st day	o ..	o ..	500 ..	o	o ..	o ..	o	500 ..	125 ..	500	75
	7th day	o ..	o ..	500 ..	o	o ..	o ..	o	500 ..	125 ..	500	75

o = under 1/50 titre.

in acknowledging assistance from Dr. John Wallace, of Weston-super-Mare, in this case.

Blood cultures were made on the first, seventh, eleventh and seventeenth days. They were all negative.

The urine was cultured on the first, seventh, eleventh and seventeenth days. Meningococci were not found. Albumin was present all the time and on the eleventh day blood and renal cells appeared. Casts were absent.

The cerebrospinal fluid was cloudy throughout and became definitely yellow three days before the patient died.

(1) *Microscopical and Cultural.*—The results of the examinations are recorded in Table A. Meningococci were isolated from the cerebrospinal fluid and the nasopharynx, and gave typical agglutinations for Type II meningococcus. After the eleventh day we failed to grow the organism from nasopharyngeal swabs and from the cerebrospinal fluid.

The meningococci isolated on the first day, before any antiserum was injected, gave typical fermentation reactions. Those obtained from seventh day specimens and afterwards, yielded definite agglutinins but failed to form acid in glucose media by the end of seven days, when the cultures were tested and found to be alive.

On the seventeenth day there was a fall in cerebrospinal fluid polynuclears. Unfortunately, total and differential blood counts were not thought of.

(2, 3, 4) *Agglutinins.*—The cere-

brospinal fluid and blood contained a small amount of agglutinin for both nasopharyngeal and cerebrospinal meningococci on the first day. The urine did not exhibit any agglutinative powers.

Turning now to the record of these results, if Table A is read from above downwards, the agglutinability of each day's coccus will be evident, while when scanned from left to right the power of the various agglutinating materials will be manifested.

First, we may note that the standard stock type emulsions were agglutinated to different degrees by the cerebrospinal fluid and blood. There is a variation also in the cerebrospinal fluid that may be ascribed, perhaps, to unabsorbed residues of the anti-serum—although the figures obtained on the first day suggest that the reaction was due to the escape of tissue fluids into the cerebrospinal canal. The blood showed an increasing agglutinative power during the first seven days, followed by a rapid fall for two and a half days before death.

The therapeutic Army serum was kept in sealed capsules and the same lot was used for all the determinations. It agglutinated the seventh day cerebrospinal fluid coccus to a greater degree than the first day coccus, although the nasopharyngeal coccus was agglutinated equally on both occasions. The Dopter serum failed to act on these cocci. At first we ascribed this to the presence of preservatives, but in one of the later cases it showed good agglutinative power.

The blood and cerebrospinal fluid on the seventh day agglutinated the seventh day coccus to a higher titre than the coccus isolated on the first day.

The features which attracted our attention in this case were :—

(1) The decreased fermentative power of the cocci on the seventh day.

(2) The increased agglutinability of the cocci during the course of the attack in the presence of the blood and cerebrospinal fluid and in the case of the cerebrospinal fluid coccus with a standard serum.

(3) The yielding and maintenance of typical serological "group" reactions.

(4) The uniform absorption of one type of agglutinin.

(5) The reactions obtained with nasopharyngeal and cerebrospinal meningococci were similar.

Case B.

Male, aged 21. Admitted to hospital on the second day with slight headache and rigid neck. He was conscious, and Kernig's sign was not present. Dopter's serum was given and there was some

improvement up to the fourth day. The condition remained the same up to the eighth day when L.I.P.M. Army serum was given. At this time there appeared serological and coccal changes recorded below and the patient became worse. On the eleventh and succeeding days, the cerebrospinal fluid was yellow in colour and reduced in amount. By the fourteenth day the quantity which could be withdrawn had fallen from sixty cubic centimetres to twenty cubic centimetres and rapid formation of a clot was evident.

On the sixteenth day the cerebrospinal canal was washed out with thirty cubic centimetres of a half strength eusol solution and ten cubic centimetres allowed to remain. On the next day, the cerebrospinal fluid was colourless and did not clot so easily; there was also an increased percentage of polynuclears with more marked phagocytosis. On the nineteenth day, as there was no improvement, eusol was again employed and twenty cubic centimetres left in the canal after washing out. Death occurred on the twentieth day.

(Eusol had been tried in a previous case in which for six weeks serum injections and vaccine had proved of no avail. The cerebrospinal fluid was thick and gelatinous and swarming with meningococci, chiefly extra-cellular. The day after ten cubic centimetres of eusol had been injected, the amount of the cerebrospinal fluid was increased from five cubic centimetres to thirty cubic centimetres and phagocytosis was present although the organisms were still plentiful. Three injections were given in all and the fluid became much clearer. However, hydrocephalus supervened and the case ended fatally.)

Agglutinins.

Stock Type Cocci Meningococci.—From Table B it is evident that Type II coccus was agglutinated by the blood and cerebrospinal fluid up to the seventh day, and that then Type I was clumped for a few days. Finally, during the later days of the attack, the type cocci were not agglutinated. For purposes of comparison, the titre of the homologous sera for the type emulsions is stated, and also that of the two curative sera for the stock cocci. The latter acted very slowly, both in diluted and standard suspensions, the end titre being reached rarely before twenty-four to thirty-six hours.

Cerebrospinal Meningococci.—For the cocci isolated on the

CASE B.

	Fluid	Type of coccus (Agglutination)	P	E	L	Cocci	Blood	Glucose	Mannose	Saccharose	Type of coccus (Agglutination)	Glucose	Mannose	Saccharose	
		Cerebrospinal Fluid—Films and Cultures—									**Nasopharynx—**				
			Film					Reactions				Reactions			
2nd day ..	Cloudy ..	II	80 ..	18 ..	2 ..	Extra-cellular ..	o	+ A_4 ..	— ..	—	—	— ..	— ..	—	Dopter serum injected.
3rd day ..	Cloudy ..	II	80 ..	15 ..	5 ..	None ..	o	— ..	— ..	—	II	+ A_4 ..	— ..	—	,, ,, ,,
4th day ..	Cloudy ..	—	50 ..	40 ..	10 ..	None ..	o	— ..	— ..	—	—	— ..	— ..	—	,, ,, ,,
5th day ..	Cloudy-clot	II	80 ..	17 ..	3 ..	None ..	o	+ A_3 ..	— ..	—	II	+ A_4 ..	— ..	—	,, ,, ,,
6th day ..	Cloudy-clot	II	Excess fibrin ..			Extra-cellular ..	o	+ A_4 ..	— ..	—	—	— ..	— ..	—	Dopter and ordinary Lister serum injected.
7th day ..	Cloudy ..	II	60 ..	30 ..	10 ..	Scanty ..	o	+ A_3 ..	— ..	—	o	— ..	— ..	—	Dopter and ordinary Lister serum injected.
8th day ..	Cloudy ..	—	80 ..	10 ..	10 ..	Occasional ..	o	— ..	— ..	—	o	— ..	— ..	—	Army Lister serum injected.
9th day ..	Cloudy ..	I	80 ..	10 ..	10 ..	Occasional ..	o	+ A_4 ..	— ..	—	o	— ..	— ..	—	Army Lister serum injected.
10th day ..	Cloudy ..	I	70 ..	20 ..	10 ..	Occasional ..	o	+ A_4 ..	— ..	—	o	— ..	— ..	—	No serum injected.
11th day ..	Cloudy ..	—	80 ..	15 ..	5 ..	None ..	Few R.B.C.	— ..	— ..	—	II	+ A_4 ..	— ..	—	,, ,,
12th day ..	Cloudy ..	—	80 ..	15 ..	5 ..	None ..	o	— ..	— ..	—	II	+ A_3 ..	— ..	—	Flexner serum injected.
13th day ..	Yellow-clot	—	68 ..	20 ..	12 ..	+ Phag. ..	+	— ..	— ..	—	II	+ A_4 ..	— ..	—	,, ,, ,,
14th day ..	Yellow-cloudy	—	60 ..	25 ..	15 ..	++ Phag. ..	+	— ..	— ..	—	—	— ..	— ..	—	,, ,, ,,
15th day ..	Yellow-clot	—	80 ..	10 ..	10 ..	None ..	o	— ..	— ..	—	—	— ..	— ..	—	No serum injected.
16th day ..	Not yellow; later deep yellow	—	60 ..	30 ..	10 ..	Occasional ..	o	— ..	— ..	—	—	— ..	— ..	—	10 c.c. half strength eusol injected.
17th day ..	Deep yellow	I	75 ..	15 ..	10 ..	+ Phag. ..	o	+ A_4 ..	— ..	—	—	— ..	— ..	—	Flexner serum injected.
19th day ..	Not yellow	I	60 ..	35 ..	5 ..	+ Phag. ..	o	+ A_4 ..	— ..	—	—	— ..	— ..	—	10 c.c. half strength eusol injected.
20th day ..	Cloudy ..	I	85 ..	12 ..	3 ..	+ Phag. ..	o	+ A_4 ..	— ..	—	—	— ..	— ..	—	..
20th day ..	Death ..	..	..	..	..	.. ..	..	..	.. ..	..	..	..	.. ..	..	..

AGGLUTINATIONS. CASE B.

Patient's own Meningococcus Isolated from—

		On Stock Cocci End titres I	II	III	Type serum IV	Cerebrospinal Fluid Cocci. End Titres 2nd day coccus	5th day coccus	7th day coccus	10th day coccus	18th day coccus	20th day coccus	21st day coccus	Nasopharynx Cocci. End Titres 3rd day coccus	5th day coccus	11th—12th day coccus	13th day coccus
Cerebro-spinal Fluid—																
A	2nd day	o	o	o		5	..	..	50	..	..	..	..	..	..	..
B	3rd day	o	o	o		Under 2	..	..	..	..	..	..	25	..	50	..
C	4th day	o	5	o		25	..	..	..	..	..	..	2	..	..	..
D	5th day	o	o	o		25	50	..	..	..	..	..	5	Under 2	..	..
EF	7th day	o	125	o		Under 2	..	50	..	..	..	..	Under 2	..	..	..
G	9th day	50	o	o		5	..	50	..	..	..	..	—	—	..	..
H	10th day	50	o	o		5	..	..	50	..	..	..	12·5	..	..	..
IJ	12th day	50	o	o		Under 2	..	..	..	..	..	..	Under 2	..	25	..
KLMN	13th—16th day	o	o	o		25	..	..	25	..	..	..	25	..	125	..
P	17th day	o	o	o		5	..	..	..	25	..	..	Under 2	..	..	2·5
Q	19th day	o	o	o		5	..	..	..	..	25	..	..	..	..	..
R	20th day	o	o	o		5	50	..	..	..	..	25	..	..	..	..
Blood		On stock cocci														
A	2nd day	o	o	o		Under 25	..	..	..	..	..	..	Under 25	..	..	..
B	3rd day	o	o	o		500	..	..	..	..	..	..	50	..	..	..
C	4th day	o	125	o		500	..	..	..	..	..	..	50	..	..	..
D	5th day	o	250	o		250	500	..	..	..	..	..	Under 25	Under 25	..	..
EF	7th day	o	125	o		125	125	500	..	..	..	..	125	..	..	..
G	9th day	250	o	o		250	..	..	..	..	..	..	Under 25	..	..	..
H	10th day	o	o	o		Under 25	Under 25	..	500	..	..	..	Under 25	..	..	..
IJ	12th day	o	o	o		250	..	..	250	..	..	..	Under 25	..	Under 25	..
KLMN	13th—16th day	o	o	o		25	..	..	50	..	..	..	Under 25	..	Under 25	..
P	17th day	25	o	o		25	..	..	..	25	..	..	Under 25	..	..	Under 25
Q	19th day	o	o	o		5	..	..	..	..	50	..	Under 25	..	..	Under 25
R	20th day	o	o	o		5	..	..	..	..	..	25	..	..	..	..
Dopter Serum		o	50	o	50	Under 25	Under 25	Under 25	Under 25	Under 25	Under 25	Under 25	Under 25	Under 25	Under 25	Under 25
Lister Serum		500	50	50	750	50	250	250	250	125	25	50	500	500	500	500

EXHAUSTION OF STANDARD TYPE SERA WITH MENINGOCOCCI ISOLATED FROM THE CEREBROSPINAL FLUID AND NASOPHARYNX OF THE CASE B.

(To save space end titres only are given.)
(o = below 1/50 dilution.)

			End Titre before Exhaustion— with cerebrospinal fluid cocci				End Titre after Exhaustion— with cerebrospinal fluid cocci				End Titre of Exhausted Sera— with corresponding standard cocci		
			Normal serum	Type serum I	Type serum II	Type serum III	Normal serum	Type serum I	Type serum II	Type serum III	Type serum I	Type serum II	Type serum III
Stock cocci			o	500	500	500					o	o	o
Cerebrospinal fluid cocci	2nd day	A	o	25	500	25	o	o	o	o	500	25	500
	5th day	D	o	o	500	25	o	o	o	o	500	50	500
	7th day	EF	o	25	500	25	o	o	o	o	500	125	500
	10th day	H	o	500	o	25	o	50	o	o	125	o	o
	18th day	P	o	500	o	o	o	25	25	o	o	o	500
	19th day	Q	o	500	50	o	o	o	o	o	o	o	500
	20th day	R	o	500	o	o	o	o	o	o	o	50	500
N-P.S. cocci	3rd day	B	o	25	250	25	o	o	o	o	500	50	500
	5th day	D	o	–	250	–	o	o	o	o	500	50	500
	7th day	F	o	–	250	25	o	o	o	o	500	50	500
	11th day	J	o	25	250	–	o	o	o	o	500	100	500

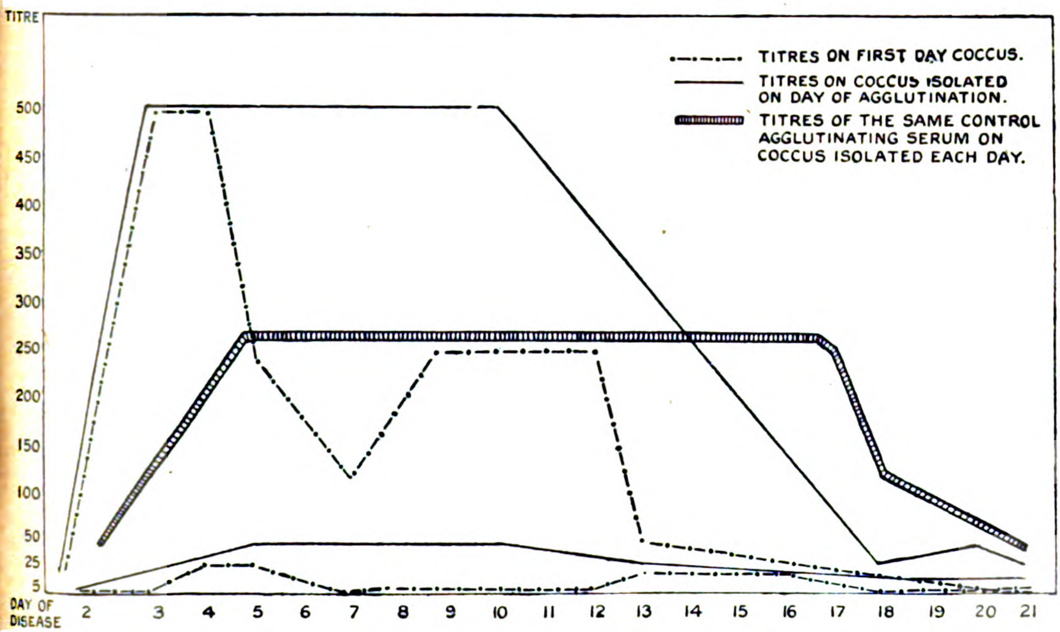
Exhaustion of Second Specimen of Standard Type Sera.

			Normal serum	Type serum I	Type serum II	Type serum III	Type serum IV	Normal serum	Type serum I	Type serum II	Type serum III	Type serum IV	Type serum I	Type serum II	Type serum III	Type serum IV
Stock cocci			o	500	500	500	500						o	o	o	o
Cerebrospinal fluid cocci	2nd day	A	o	25	500	o	50	o	o	o	o	o	500	25	500	250
	5th day	D	o	o	500	o	o	o	o	o	o	o	o	o	o	500
	7th day	E	o	25	250	o	25	o	o	o	o	o	250	125	500	500
	10th day	H	o	500	250	o	25	o	o	o	o	o	250	50	500	500
	18th day	P	o	75	o	15	25	o	o	o	o	o	500	o	15	25
	19th day	Q	o	o	o	o	25	o	o	o	o	o	o	25	500	500
	20th day	R	o	500	250	o	o	o	o	o	o	o	o	125	o	500
N-P.S. cocci	3rd day	B	o	o	250	25	25	o	o	o	o	o	500	125	500	500
	5th day	D	o	o	o	o	25	o	o	o	o	o	500	50	500	500
	7th day	F	o	o	250	25	o	o	o	o	o	o	500	50	500	500
	11th day	J	o	25	250	o	o	o	o	o	o	o	500	125	500	500

second day of the attack the titre of the blood and cerebrospinal fluid rose for four days and then commenced to fall.

When the blood or cerebrospinal fluid was added to an emulsion prepared from the meningococcus isolated on the day the serum was collected, the titre remained high, after an initial rise, until the tenth day, and then fell gradually. These features are brought out in Chart I.

Chart I.—Agglutination Titres of Blood and Cerebrospinal Fluid on Meningococci isolated during Acute Attack.



Upper curves represent blood titres. Lower curves represent cerebrospinal fluid titres.

Of the curative sera, the Dopter variety failed to agglutinate any of the organisms, while to the Lister serum the organisms became more agglutinable up to the fifth day, and less agglutinable after the seventeenth day.

A further glance at Table B reveals the fact that when the blood or cerebrospinal fluid was tested against the coccus of the day and the coccus isolated on preceding days, there was a distinct difference between the end titres registered. For instance :—

7th day blood agglutinated	7th day coccus 1/500
	5th day coccus 1/125
	2nd day coccus 1/125
7th day cerebrospinal fluid agglutinated	7th day coccus 1/50
	2nd day coccus 1/5
21st day blood agglutinated	20th day coccus 1/25
	2nd day coccus 1/5
Curative serum agglutinated	7th day coccus 1/250
	2nd day coccus 1/500
	20th day coccus 1/25
	21st day coccus 1/50

Nasopharyngeal Cocci.—With the meningococci isolated from the nasopharynx, the Lister Army serum gave a permanently high titre. The blood, on the other hand, yielded a low titre, and after the seventh day failed to produce agglutination in a 1 in 25 dilution. It might have been possible to prove the presence of a slight amount of agglutinin power had lower dilutions been employed, for the cerebrospinal fluid produced lower titre agglutinations up to the seventeenth day. Too much regard cannot, however, be paid to these, as they might be attributed with reason to the residues of the injected serum. It is of interest, however, to observe the lowered quantity or disappearance of the agglutinins in the blood collected after the tenth day, both with earlier and later isolated nasopharyngeal meningococci, for it was on the tenth day that the blood and cerebrospinal fluid commenced to clump with a Type I coccus, and did not agglutinate a Type II coccus. The nasopharyngeal cocci were consistently Type II according to present criteria and the same stock serum, while the standard serum yielded the same titre throughout.

These changes in the agglutinability of the successive isolated cocci in the standard curative serum and in the blood and cerebrospinal fluids, and the alteration in the agglutinative power of the tissue fluids upon stock Type I and II emulsions, made necessary a re-testing of the standard materials with which we were working. They were, therefore, put through all possible tests and controls. The results did not show any deviation from their original titres.

Next, it was considered worth while to test the cerebrospinal meningococci against other lots of type sera. The figures on next page were obtained. The differences do not excite remark.

A further obvious step was to examine the absorption capacities of the isolated meningococci, in order to discover how far the differences in the agglutinability during the acute attack were due to a so-called agglutinoid change; that is to say, whether or not

the meningococci removed from the sera the conditions which previously determined the agglutinations, although clumping was not produced.

Cerebrospinal fluid cocci	Type Serum I end titre	Type Serum II end titre	Type Serum III end titre	Type Serum IV end titre	Immune standard serums Marked
A. 1st day	25	500	25	–	X
A. 1st day	25	500	0	25	Y
H. 10th day	500	0	25	–	X
H. 10th day	500	0	25	–	Y
H. 10th day	500	250	25	–	Z
P. 18th day	500	0	0		X
P. 18th day	75	0	15	25	Z
R. 20th day	500	250	0	–	Y
R. 20th day	500	250	0	0	Z

0 = under 1/25.

Absorption Capacities of the Isolated Cerebrospinal and Nasopharyngeal Meningococci.

The various cocci yielded by the several lumbar punctures and nasopharyngeal swabs were submitted to absorption tests performed with the method and its precautions stated above. After the appended findings had been obtained from the standard immune type serum X, the experiments were repeated with sera Y and Z.

With the first serum used for absorption it will be seen that up to the seventh day the cerebrospinal cocci removed the greater part of the agglutinin for Type II and failed to affect that for Types I and III. With the second serum similar results occurred, although the fifth day organism furnished irregular figures.

After the seventh day onwards, with the first serum, there was an absorption of the agglutinin for both Types I and II with the first serum, together with the partial loss of agglutinin with Type II serum and definite agglutination with Type I. With the second serum the results were less regular, but not discordant.

The comparison between the two sera may be better appreciated by calculating the percentage amount of agglutinin removed by the respective cocci. This is shown in Table E.

It will be noted that the absorption results are as approximate as the present-day serological technique would lead us to expect.

In the case of nasopharyngeal isolations, with both the first and the second lot of sera, the cocci removed the agglutinin for the number II type only.

TABLE E.—Comparison of Absorption Results from Two Samples of Standard Sera.

Cerebrospinal fluid cocci	First Sample Agglutinin absorbed Percentage Type I	First Sample Type II		Second Sample Agglutinin absorbed Percentage Type I	Second Sample Type II
A. 2nd day	–	95	A.	–	95
D. 5th day	–	90	D.	100	100
E. 7th day	–	75	E.	50	50
H. 10th day	75	100	H.	50	95
P. 17th day	100	100	P.	0	100
Q. 19th day	100	100	Q.	100	95
R. 20th day	90	100	R.	100	75
Nasopharyngeal cocci					
B. 3rd day	–	90	B.	–	75
D. 5th day	–	90	D.	–	90
F. 7th day	–	90	F.	–	90
J. 11th day	–	80	J.	–	75

If we summarize the estimations carried out in this case, it appears that:—

(1) The blood and cerebrospinal fluid exhibited agglutinative powers for the cocci present in the tissues at the time of removal which varied from those possessed for the cocci obtained from the tissues on previous days.

(2) The blood and cerebrospinal fluid developed agglutinin about the seventh day for a group of stock cocci which were of a different "type" from that to which the earlier cocci were ascribed and that from this period onwards the agglutinin content fell and the clinical condition became less favourable.

(3) The blood failed to agglutinate the isolated nasopharyngeal cocci after the tenth day, although nasopharyngeal meningococci were obtained up to the thirteenth day.

(4) The cerebrospinal cocci became more agglutinable to curative sera up to the seventeenth day and less agglutinable afterwards; more agglutinable to the tissue fluids up to the tenth day and less so onwards.

(5) With one immune serum the cerebrospinal cocci absorbed agglutinin from Type serum I up to the seventh day and afterwards from Type sera I and II and with another serum from Type I up to the fifth day and afterwards from both I and II.

Case C.

Female, aged 13 months. Admitted on the fourth day with drowsiness, marked head retraction, positive Kernig without rash. On the sixth day the cerebrospinal fluid was thick and gelatinous; ten cubic centimetres were withdrawn and Dopter's serum injected.

The next day, only 5 cubic centimetres of fluid were obtained; 15 cubic centimetres of half strength eusol were injected into the canal. On the following day, 40 cubic centimetres of opalescent watery fluid flowed out and during the three next days the fluid remained clear. There was also increased phagocytosis and fewer cocci were found. Dopter's serum was given. From the eleventh to the fourteenth days the child was a little better; 38 and 25 cubic centimetres of opalescent fluid were drawn off on the fifteenth and sixteenth days; from the seventeenth to the twenty-first days the patient seemed more comfortable. No more fluid has been obtained up to date and the child has lapsed into a typical chronic state.

Here, again, the injection of eusol was followed by the conversion of a thick, gelatinous, coagulable fluid into a much clearer, non-coagulable exudate considerably increased in amount.

In both these cases the quantity and strength of eusol did not appear to cause pain or toxic manifestations.

Meningococci and Ferment Reactions.

The ferment reactions were normal throughout. The cultural and morphological appearances were the same on each occasion. Nasopharyngeal meningococci were not demonstrable.

Agglutinations with Blood Sera and Cerebrospinal Fluid.

The blood serum and cerebrospinal fluid agglutinated the fourth day coccus to the same extent up to the sixteenth day, viz., 1 in 250 to 1 in 500. With the cocci obtained on the sixth and fifteenth days, however, the titre rose to 1 in 1,250, and with the cocci obtained on the sixteenth day to 1 in 1,500, while with the fourth day coccus, it was considerably lower. Another feature to which we may draw attention is the delayed development of the reaction with stock emulsions. In Case B, agglutinin was absent until the fourth day. In this case it was not until the seventh day that a definite result was attained. Type II coccus was the group then selected and no modification occurred.

This was the first instance in which Dopter's curative serum agglutinated the cerebrospinal cocci isolated from these cases. Previous failures had been ascribed to the presence of preservatives or the age of the serum, but in this case definite and good agglutinative powers were manifested. The titres of both the Dopter and Lister serum remained at the same level in all the estimations; however, it may be pointed out that the early titre was not

CASE C.

Cerebrospinal Fluid—Films and Cultures—

Fluid	Type of Coccus (Agglutination)	Film: P.	Film: E.	Film: L.	Film: Cocci	Film: Blood	Reactions: Glucose	Reactions: Mannose	Reactions: Saccharose	(Meningococcus not obtained from Nasopharynx)
4th day, cloudy	II	80	15	5	Phag. + +	o	+ A_4	–	–	..
6th day, cloudy	II	60	35	5	Occasional	o	+ A_4	–	–	Dopter serum injected.
7th day, blood	..				..			..		10 c.c. eusol solution injected.
8th day, yellow	II	70	20	10	Phag. +	+	–	–	–	Dopter serum injected.
9th day, yellow	II	70	10	20	None	+	–	–	–	
15th day, cloudy	II	55	40	5	Occasional	o	+ A_4	–	–	
16th day, cloudy	II	65	25	10	Occasional	o	+ A_4	–	–	

AGGLUTINATIONS. CASE C.

End Titres.

	Stock Cocci Strains: I Titre	II Titre	III Titre	IV	Patient's own Meningococcus isolated from— Cerebrospinal Fluid: 4th day coccus Titre	6th day coccus Titre	15th day coccus Titre	16th day coccus Titre
Cerebro-spinal Fluid—								
4th day	–	–	–		5	–	..	..
6th day	–	–	–		Under 2	Under 2	..	..
15th day	–	–	–		5	..	5	..
16th day	–	–	–		..	..	5	5
Blood—								
4th day	–	–	–		250	–	..	..
6th day	–	–	–		250	250	..	..
7th day	–	500	–		500	1,250	..	..
8th day	–	500	–		500	1,250	..	..
9th day	–	500	–		500	1,250	..	..
10th day	–	500	–		500	1,250	..	..
15th day	–	125	–		500	1,250	1,250	..
16th day	–	125	–		..	..	..	1,500
Dopter serum	o	50	o	50	250	250	250	250
Lister serum	500	50	50	750	500	500	500	500

EXHAUSTION OF STANDARD TYPE SERA. CASE C.
(o = below 1/50 dilution.)

	End Titre before Exhaustion— With Cerebrospinal Fluid Cocci				End Titre after Exhaustion— With Cerebrospinal Fluid Cocci				End Titre of Exhausted Sera— With corresponding Standard Cocci			Agglutinins absorbed
	Normal serum	Type serum I	Type serum II	Type serum III	Normal serum	Type serum I	Type serum II	Type serum III	Type serum I	Type serum II	Type serum III	Per cent
Stock cocci	o	500	500	500					o	o	o	
4th day, cerebrospinal fluid cocci I	o	o	500	25	o	o	o	o	500	50	500	90
6th day, cerebrospinal fluid cocci II	o	o	500	o	o	o	o	o	500	50	500	90
15th day, cerebrospinal fluid cocci VII	o	o	500	o	o	o	o	o	500	125	500	75
16th day, cerebrospinal fluid cocci VIII	o	25	500	25	o	o	o	o	500	50	500	90

determined, as lumbar puncture could not be carried out before the fourth day. Had a test been possible on the first day, the findings in the previous case might have been repeated. It will be noted that the titre of the curative sera is higher for the cerebrospinal cocci than for the stock cocci.

Absorption Capacities.

The absorption experiments yielded results which coincided with those of the agglutinations.

Case D.

Male, aged 2. Admitted to hospital on the tenth day with retracted head, opisthotonus, positive Kernig, and a faded petechial rash. Seven consecutive daily injections of Dopter's serum were given. There was very little change until the sixteenth day, when rapid improvement set in. This was associated with a change in the ferment activities of the cerebrospinal meningococcus. A relapse occurred on the twenty-first day. Two more injections of Dopter's serum were administered. From this point convalescence was uninterrupted.

In this case, which did not come under examination until late in the attack, we met with another example of a change in fermentation reactions on the sixteenth day. The meningococcus lost its power to produce acid in glucose media; precautions were taken to prove that the coccus was still alive, and the reactions were attained in several subcultures.

CASE D.

	Cerebrospinal Fluid—Films and Cultures—									
	Type of Coccus	Film					Reactions			
	(Agglutination)	P	E	L	Cocci	Blood	Glucose	Mannose	Saccharose	
12th day	I	70	20	10	++ Phag.	o	+ A_4	–	–	Dopter serum injected daily
16th day	I	10	80	10	+ Phag.	o	+ No A	–	–	..
19th day	I	80	10	10	+ Phag.	o	+ No A	–	–	..
Recovery	..	..	..	..	..	..	..	..	..	..

AGGLUTINATIONS. CASE D.

End Titres.

	Stock Cocci Strains				Patient's own Meningococcus isolated from— Cerebrospinal Fluid	
	I	II	III		10th day coccus	16th day coccus
	Titre	Titre	Titre		Titre	Titre
Cerebro-spinal Fluid—						
10th day	–	–	–		25	–
16th day	–	–	–		–	25
19th day	–	–	–		Under 2	Under 2
Blood—						
10th day	–	–	–		10	–
16th day	–	–	–		50	50
19th day	–	–	–		Under 25	Under 25
	I	II	III	IV		
Dopter serum	o	50	o	50	Under 25	Under 25
Lister serum	500	50	50	750	125	125
Urine	o	o	o	..	o	..

EXHAUSTION OF STANDARD TYPE SERA. CASE D.

	End Titre before Exhaustion—				End Titre after Exhaustion—			End Titre of Exhausted Sera— With Corresponding Standard Cocci			Agglutinins Absorbed	
	Normal serum	Type serum I	Type serum II	Type serum III	Type serum I	Type serum II	Type serum III	Type serum I	Type serum II	Type serum III	Type I	Type II
Stock cocci	o	500	500	500				o	o	o		
Cerebrospinal fluid cocci .. 12th day	o	500	125	o	o	o	o	250	250	500	50	50
16th day	o	500	50	o	o	o	o	125	250	500	75	50

o = under 1/50.

The blood and cerebrospinal fluid yielded a low agglutinin titre for the meningococci isolated, and did not present any difference in agglutinating power for the organisms recovered on the tenth and the sixteenth days, and failed to clump any stock emulsions. Agglutinin was not demonstrable on the sixteenth day, and the child recovered.

The therapeutic sera showed the same titre on both days.

Absorptions placed the coccus in the same grouping as Case B coccus at the close of the attack.

SUMMARY AND REMARKS.

It is perhaps as well to invite consideration of our attempts to attain results easily comparable by other workers. In addition to the use of emulsions and sera standardized by the Central Laboratory and supplied by the Medical Research Committee, our own suspensions have been prepared in accordance with the instructions issued by the Central Cerebrospinal Fluid Laboratory for agglutinin determinations. The agglutinations and absorptions have been carried out by one worker and subsequently checked by a second one. The primary and secondary media used for the whole of the cultures were identical as to composition and each case had its own batch of liquid sugar media. The collection of material has been made by our own hands and Cases B, C, and D have been under the care of the same clinician (B. A. I. P.).

As we have endeavoured to record impartially the several types of

findings, we trust that our statements do not bear the stamp of unjustified interpretation. If they have appeared to us to warrant a continuance of similar work we may ask that our discussion of them will be understood more as a request for further inquiry than as an enunciation of an hypothesis. If we have been led to labour the point that an organism is modified during the course of an acute attack, we hope that we may be pardoned therefor when it is remembered that the meningococcal infection is one of the very few which permits of a continuous and untrammelled examination of the parasite during its tussle with the defensive apparatus of the human host.

Bearing these points in mind, a summary of the cases examined may be acceptable in the following form :—

(1) Two cases yielded meningococci which exhibited a change in their fermentation reactions after the seventh day.

(2) Three cases showed a different agglutinating power for the first coccus isolated and for those subsequently recovered. This variation was manifested by the blood and to a less degree by the cerebrospinal fluid. The agglutination of stock type emulsions by the selfsame blood and cerebrospinal fluid was lower and slighter; in one case it was not evident.

(3) One case yielded :—

(*a*) A meningococcus, which after the seventh day failed to agglutinate with the type immune serum which had previously produced agglutination, although it absorbed agglutinin from it. It was, however, agglutinated by another group serum and exhibited absorptive powers for its agglutinin contents.

(*b*) Blood and cerebrospinal fluid which agglutinated one type of meningococcus up to the seventh day, and another type afterwards.

(*c*) Nasopharyngeal meningococci which retained type manifestations up to the time of their disappearance.

(4) These changes corresponded with definite clinical signs of improvement or failure of response.

(5) Intraspinal injections of eusol solution have been employed. They did not stay the progress of the disease, but were followed by a lessening of the gelatinous consistence of the exudate, an increase in its amount, a decrease in the number of meningococci with augmented phagocytosis and a disappearance—sometimes complete—of the yellowness of the fluid withdrawn.

How far these variations are representative of other cases and

the importance that should be attached to them with regard to the serological problems of the day, the transmission of meningococci, and the possible types of the infecting organisms, are questions which depend naturally upon the results of additional work. But in the meantime it is worth calling to mind that in the excellent brochure on cerebrospinal fever recently issued by the Local Government Board, W. M. Scott (p. 67) foreshadows the possibility of modifications of the meningococcus through contact with human tissues. In some examinations of the nasopharynges of carriers, Scott found that meningococci isolated at intervals of some weeks yielded varying agglutinin reactions with four standard monovalent immune sera. He did not obtain any morphological or cultural differences from the various organisms, but still turns rather from his first reflection to the probability of replacement of the primary infective bacteria by original permanent forms which had been swamped at first by the entry of the stronger parasite. In view of the mixed flora of the nasopharynx, his conclusion was perhaps the only one permissible.

In our cases, although we have had to deal with a localized persistent pure infection, it is possible also that several groups of meningococci took part, and that one became predominant at one period, a second at another one. Like Scott, we were unable to detect any specific differential characters. From the serological standpoint, however, we were placed to better advantage in that we were enabled to observe the micro-organisms and their reactions from day to day, and to test the responses of the tissue cells to their irritant action. Without expanding our slender records unduly, we feel that we have sufficient grounds to permit of the statement that it seems reasonable to expect that some aspects of the problems associated with the grouping of meningococci may be solved by further study on similar lines.

Theoretically, the application of Griffith's hypothesis (L.G.B., p. 55) would furnish an explanation of these changes by the adaptation of the meningococcus to the circumstances demanding the employment of its specific antigenic components A or B, or both. Dr. Griffith thus opens up a pathway for the chemist which, we may hope, will soon be trodden ; for a knowledge of the broader lines of action—due to protein-free or amino-molecules—is essential to further progress. Under the conditions we have investigated, this view might be extended to include the tissue response as a determining factor, and the change of antigenic effort as a reply on the part of the coccus. In other words, the modification was

induced during an acute attack and the transmission of the altered bacterium would result in an infection with a meningococcus differently armed—and later "grouped"—although "inseparably linked" to its original type by its derivation, morphology and cultural characters.

Finally, it remains to consider whether the absorption of the injected antiserum was responsible for some of our findings. We included the estimations of the agglutinative effect of curative sera in order to make any necessary deductions from our figures. When we found that the titres of the sera for the meningococci isolated was, as a rule, considerably below that of the blood, and when we calculated the daily dilution of three and a half litres of blood by the uncombined residues of ten to thirty cubic centimetres of antiserum injected, it was possible only to conclude that the influence of the antiserum upon the agglutinin contents of the peripheral blood was a factor which might be disregarded.

From the practical standpoint, since the extent of agglutination is adjudged useless as a sign of the severity of an attack, it may be worth the while to observe whether any change in ferment reactions, or alterations in type of coccus, or variations in absorptive capacities, are associated with the clinical signs which we have met with.

Literature.—Local Government Board, Report on Cerebrospinal Fever, 1916; Medical Research Committee, Report on Cerebrospinal Fever, 1916; Cerebrospinal Fever, Foster & Gaskell, Cambridge University Press, 1916; Gordon and others, JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, 1914-15. It will be found that these are all indispensable to workers on this subject. They contain full bibliographies and are most stimulating and helpful whether they are referred to for statements of facts or impartial criticism.

ADDENDUM.

Since the dispatch of our MS. we have had the opportunity to examine another case of cerebrospinal fever. It has yielded results which point to alterations in fermentative reactions, agglutinability and absorptive capacity similar to those met with in the cases recorded. The agglutination and absorption variations support the observations made in Case B; they were associated again with clinical signs for the worse.

Case E.

Man, aged 27, admitted on third day; unconscious, with well-developed rash.

After removal of cerebrospinal fluid and injection of Dopter's serum, temperature and pulse fell. Army serum given on fourth day, but temperature rose gradually to 106° F. just before death.

Films prepared from the cerebrospinal fluid showed the organisms to be chiefly extra-cellular; phagocytosis was slight. The organisms became more numerous and increased in size.

Cultures did not reveal any morphological differences nor did various colonies taken from each day's growth show any variations in fermentative reactions.

	Third day		Fourth day		Fifth day
	Morning	Evening	Morning	Evening	Death
Fermentations—					
N.P.S. meningococcus					Not obtained.
Cerebrospinal fluid meningococcus	GA_3, S –	GA_3, S –	GA_2, S –	GA_2, S –	–
Agglutinations—					
Standard sera	Type II 500	Type II 500	Type II 500	Type II 500 Type I 500	–
Patient's blood	1/25	1/25	o	o	–
Patient's cerebrospinal fluid	1/25	1/25	o	o	–
Army serum	o	o	o	o	–
Dopter serum	o	o	o	o	–
Absorptions—					
With standard immune sera	Type II 500	Type II 500	Type II 500	Type II 500	–
			Type I 375	Type I 500	–

o = under 1/25.

Blood and cerebrospinal fluids did not agglutinate stock strains of cocci.

It will be noted that the agglutinative power disappeared from the blood on the fourth day; that the fermentative changes were more rapid with the fourth day organisms; that the isolated cocci were agglutinated by Type II serum at first and later by Type I serum; that the cocci absorbed Type II agglutinin at first and afterwards both Type II and Type I agglutinins.

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A REPORT ON THE USE OF STOCK VACCINE IN INFECTION BY THE *BACILLUS TYPHOSUS*, WITH AN ANALYSIS OF TWO HUNDRED AND THIRTY CASES.

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Royal Army Medical Corps.

Methods Adopted in the Investigation.

The two hundred and thirty cases under consideration were in hospital during the winter 1914-1915. Half the cases were in my medical charge, the remainder being in the wards of Major Johnstone, Captain J. A. Torrens, Captain G. D. H. Wallace, and other medical officers. Careful notes were taken, and a summary of each case was made at its termination by the particular medical officer, and I am much indebted to them.

The notes of the cases were made on the same plan, which was carried out with various modifications by the other officers. At the end of the winter, with the cases fresh in mind, an analysis was made of my series. About 500 cases of the enteric group have now passed through my wards, and after this additional clinical experience an attempt has been made to judge the effects of vaccine, and to reconsider all the typhoid cases which have had this treatment.

To be certain of effects of the vaccine in any particular case is a difficult matter, as mere impressions in isolated cases often prove false. Vaccine given to a patient in the hope that it will do good is liable to get the credit of his excellent recovery, when there is no proof that he would not have done equally well without it. How, then, is one to judge of the effects? It is obvious that, even if a scientifically accurate method were available, carefully selected controls are necessary, and that impressions have to be checked by a comparison between the vaccinated cases and the unvaccinated controls, and that *groups* of the same kind of case should be compared with other control groups.

Altogether 176 cases have had vaccine treatment. The cases now considered number 230; half of these were on vaccine treatment, and the other 115 are the selected controls. To make a just comparison between the two sets of cases has been the object of this investigation. The analysis of the cases incidentally shows

what were the usual course and complications of the disease among the soldiers in this hospital during the winter 1914-1915.

The Selection of the Cases.—In order that cases of typhoid fever may be rightly compared they must conform to certain standards. It was by a rigid conformity to these standards that the cases were reduced in number to two hundred and thirty.

First, it must be certain that all the cases are *true* typhoid fever, and not merely due to one or other of the three organisms of the enteric group. For this reason neither the expression "typhoid fever," nor "enteric fever" was used in the title of this paper, as both these terms are often still applied clinically to any case of the enteric group.

Paratyphoid fever is in the great majority of cases a much milder disease than typhoid fever, the average prognosis being better in every way, and the death-rate much lower.[1] In the early days of this hospital there had not been time or material to put the laboratory into proper working order. Many cases, therefore, were considered "typhoid fever" on clinical grounds, or after the isolation from them of a Gram-negative motile bacillus which did not ferment lactose. Several such cases were treated with vaccine, and, making a good and rapid recovery, were considered at the time good results for this treatment. Further investigation of the organisms from some of these patients proved that the disease had been paratyphoid fever and, as one came to recognize the usual course of this disease, it was seen that these so-called good results were fallacies (*see* Case 0).

It is with this memory of some of our earlier mistakes that I place the bacteriological proof of the cases as the first essential. The hospital has been most fortunate in having several bacteriologists thoroughly acquainted with the bacilli of the enteric group. It is especially due to the work of Captain J. L. Wood, R.A.M.C., and of Captain W. H. Tytler, C.A.M.C., that the cultures of the organisms obtained from the cases are now in the laboratory, each indexed with a full account of their reactions and the stringent standards to which they had to conform before being finally named. An analysis would have been useless without this sure foundation of the accurate bacteriological diagnosis of the cases; 205 of the 230 cases had the *Bacillus typhosus* isolated from them. Of these,

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[1] Torrens and Whittington: "The Clinical Aspects of Paratyphoid Fever," *Brit. Med. Journ.*, November 13, 1915, and JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, October, 1915.

177 were isolated from the blood-stream, 20 from the stools and 8 from the urine. In 43 of the fatal cases a post-mortem examination was made, and in 26 of the cases the *B. typhosus* was isolated from the gall-bladder and in 8 from the spleen. The remaining 25 cases, from which the organism was not isolated, were identified by the fact that their serum agglutinated the *B. typhosus* before vaccine was given, and as all were uninoculated this seems sufficient. All cases in which the laboratory evidence was incomplete or equivocal or suggested a double infection have been excluded. Cases sent in as "bacteriologically diagnosed enteric" or "typhoid" are not necessarily included, as often all that was meant was that one of the organisms of the enteric series had been isolated.

The state of inoculation complicates the question of typhoid fever among soldiers. One cannot properly compare the effect of vaccine in unprotected cases with that in cases which already have had some variable amount of protection given them by the use of the same vaccine. Also serious cases are comparatively rare among inoculated men, and thus only a few inoculated cases have been treated by vaccine at this hospital. For these reasons I have paid special attention to the uninoculated cases. Two hundred of the series are of this kind, 100 treated with vaccine and 100 unvaccinated controls. A few cases have been included in which the protective inoculation was given during the apparent onset of the disease (Case 164).

The varying severity of the disease in individuals and the fact that some cases come under treatment late and others early in the course of their fever make comparisons difficult. In analysing the cases I have divided them into classes according to their apparent severity at the time of admission and into groups according to the prognosis. Similar classes and groups of cases can then be compared according as they have or have not been on vaccine treatment. It is well known that typhoid fever varies not only in its incidence but also in its severity according to the year and season of the year, the climate and locality, and the age and sex, and that the incidence of the complications is much affected by these factors. To judge the results of a method of treatment of any infectious disease, but especially of typhoid fever, the above conditions should be constant. The cases now considered occurred between November and May, the great majority occurring during the months of December to March inclusive. They came from the comparatively small area occupied at that time by the troops of the Expeditionary Force. Finally, the patients all being soldiers,

age and previous health were fairly constant. In this connexion it should be remembered that lack of care early in the disease increases the severity and mortality rate. To sum up, in judging the effect of vaccine in typhoid cases I have tried to be certain of the following essentials (without which results will be fallacious):—

(1) Proof of infection by the *B. typhosus* in all the cases, including the controls.

(2) Accurate selection of these control cases, that is, (*a*) as far as possible the classes of cases and groups of cases compared are of the same degree of severity; (*b*) there is the same state (or lack) of inoculation in the cases compared; (*c*) all the cases occurred in the same season of the year and in the same climate and locality; (*d*) all were of the same sex and of about the same age and previous health; (*e*) other modes of treatment (nursing, etc.) were similar.

Clinical Grouping of the Cases.—The classes referred to, into which the 230 cases were divided, varied according to the apparent condition of the patient on admission or after observation for a day or two, each class of vaccinated cases having a control class of the same size. It should be noted that the final result of the case was not taken into account, but the state of the case before treatment was started. I will briefly explain the method of this classification. A flushed, drowsy patient, obviously ill, is said to be looking "toxic" (Cases 112, 162 and 8, etc.), and this expression is used by all the medical officers in describing their cases. For instance, a patient who has a typical typhoid aspect with a sallow, muddy complexion and malar flush, who is lying inert on his back, mentally fuddled or delirious, and looking obviously poisoned is described as "very toxic," whereas an alert, mentally clear man, merely looking slightly febrile, is described as "quite non-toxic." The severity of the case usually, but by no means always, varies directly with the degree of toxæmia thus evident. In judging the severity the following points were especially considered:—

(*a*) The rate and type of the pulse.
(*b*) The amount of pulmonary involvement.
(*c*) The temperature.
(*d*) The amount of distension.
(*e*) The day of the disease.

The day of disease is counted from the day which appeared by the previous history to be the first day of illness. On these lines the two hundred and thirty cases were divided into:—

Class 1.—Thirty-two cases, very severe and very toxic.

Class 2.—Eighty-six cases, severe and toxic.

Class 3.—Fifty-six cases of moderate severity.

Class 4.—Forty-four cases, moderately severe, but quite non-toxic.

Class 5.—Twelve cases, mild.

The Vaccine and Dosage.—The vaccine used (with four exceptions) was the stock Army vaccine made up for treatment purposes in the dilution of 250 millions to the cubic centimetre. The other four cases had a sensitized vaccine. The initial dose, the interval between the doses, and the rate of increase of the dose, were all the subject of careful trial, and in many of the earlier cases I had the benefit of the advice of Colonel Sir William Leishman. A small initial dose of 80 to 100 millions was tried in certain cases, but this did not seem sufficiently strong. There were some patients who had received their first inoculation during or immediately before the apparent onset of the disease (Case 164), and who were therefore considered to have had a big dose of vaccine (500 or 1,000 millions) early in their attack. Some of these patients did unusually well, and therefore a similar big initial dose was tried in other cases (Case 162). Also these and other cases seemed to support the view that the sooner the vaccine was given the better was its chance of doing good; but later there were some cases of this variety which did badly. At one time we had the impression that it was very important to get the vaccine in early; but perhaps this was due to the obvious fact that the sooner any case comes under ordinary treatment (bed, nursing, and dieting), the better chance has that patient of doing well. Eventually a first dose of 200 to 250 millions was given as a routine, and subsequent doses were usually injected at intervals of two to three days, rising by about 100 to 200 millions each time to 500 or 600 millions. The time of day for injection was varied in nearly all cases. I gave my patients their injections between 5 and 7.30 p.m., i.e., when the temperature was usually rising. The other medical officers gave the injections during the morning, when the temperature was down or falling. It was thought that, as there is frequently a decided difference in the temperature and state of the patient as observed in the morning and in the evening, the time of day might be important, but the result did not support this view. It seemed both impossible and unwise to keep to any strict rule, and the system of dosage varied much with the individual case. If there was much local reaction, or if there appeared to be a marked general reaction, there was no increase of dose, or the increase

was more gradual. Also if there was no local reaction, and apparently no general reaction, a bigger dose was often given the next day.

To be certain that a general reaction to the vaccine has occurred at any particular time in the course of a case is most difficult. All the medical officers here, after observing a large number of cases, eventually came to the conclusion that the temperature chart was a fallacious guide to the effect of any particular dose. In this matter I am unable to follow those who have described cases of typhoid fever in which rises and falls in the temperature were stated with assurance to have been due to the vaccine. Many of the control cases would have been considered good results for vaccine had they received it (Case 23).

The Results.

(1) *The Whole Series of* 230 *Cases* (115 *Vaccinated*, 115 *Selected Controls*).

The total *mortality* in the 230 cases was 52 (22·6 per cent), this being made up by 29 deaths in the vaccinated cases (25 per cent) and 23 deaths in the unvaccinated (20 per cent).

The average *length of the primary period of pyrexia* (neglecting fatal cases) was 27·5 days. The average date on which the temperature settled was the twenty-ninth day in the vaccinated cases and the twenty-sixth day in the controls.

The total number of cases having a *relapse* was 22 (9·5 per cent), and of these 12 occurred among the vaccinated and 10 among the unvaccinated. In this investigation a relapse was taken to mean a rise of temperature lasting several days, during which there was some recurrence of the previous typhoid symptoms and signs. Rises of temperature due only to a complication or sequela are not included. The total number of patients with complications or sequelæ of some kind or another was 111, and of these 58 were among those who had vaccine and 53 among the unvaccinated. The more important of these complications were distributed as follows:—

	In the total 230 cases	In the vaccinated	In the controls
	Per cent	Per cent	Per cent
Hæmorrhage	30 cases (13·0)	17 cases (14·7)	13 cases (11·2)
Perforation	7 ,, (3·0)	5 ,, (4·3)	2 ,, (1·7)
Thrombosis and phlebitis ..	7 ,, (3·0)	4 ,, (3·4)	3 ,, (2·6)
Severe post-typhoid debility or prolonged convalescence	33 ,, (14·0)	19 ,, (15·7)	14 ,, (12·0)

"Hæmorrhage" does not include the fairly numerous cases in which only streaks of blood or minute quantities were present in the stools: Hæmorrhage from the bowel was the cause of death or the deciding factor in six of the fatal vaccinated cases and in five of the controls. It was noted that in some of the cases the hæmorrhage started just after a dose of vaccine or recurred after a dose (*see* Cases 162 and 164). Such cases may have been coincidences, like many other things, good and bad, which occur during vaccine treatment. There is, however, the possibility that after a dose a greater inflammatory reaction may occur in the ulcerated Peyer's patches, and the increase in the local blood-pressure then occurring at these spots may be the decisive cause of the bleeding.

Pulmonary involvement and *meteorism* are not in the above list, as, except in the mildest cases, there is always more or less chest trouble and more or less abdominal distension, and it has seemed difficult to say at what stage conditions so frequently present become complications, and are no longer to be considered part of the usual course of the disease. It seems certain, however, that vaccine has no power to prevent or to produce them, or to diminish them when present except in so far as it may effect the general health of the patient. The presence or absence of these conditions was always carefully noted in attempting to judge the effect of vaccine, and the vaccine rarely seemed to have any good effect in cases with much bronchitis or broncho-pneumonia.

[*Note.*—It must be remembered that (*a*) this high death-rate is the rate for a particular series of cases only; (*b*) that 200 of the cases were uninoculated, and that they occurred during the winter months, and many of them under adverse conditions unavoidable at that time (slow evacuation to fever hospital, etc.); and (*c*) that 177 of them had the *B. typhosus* isolated from the blood-stream, and were therefore very definitely infected.]

The present death-rate at this hospital of the true typhoid cases is 12·3 per cent, being made up of a rate of 16·5 per cent in the uninoculated, and 8·1 per cent in the inoculated (November, 1915).

(2) *In the* 200 *Uninoculated Cases* (100 *on Vaccine and* 100 *Controls*).

In the 200 cases		In the vaccine series	In the controls
Mortality	47	25 per cent	22 per cent.
Average length of pyrexia in days	27·5 days	29·4 days	26 days.
Number of cases with relapses ..	19	10 per cent	9 per cent.
Number of cases with complications or sequelæ	101	51 ,,	50 ,,

These results require a close analysis to show how the various types of case were affected. The classes will now be dealt with separately. (For summary see table.)

Class 1.—Very severe and toxic, 28 cases (14 with vaccine and 14 without).

(*a*) *Among the vaccinated cases* there were nine deaths (64·2 per cent) and five recoveries. Of the fatal cases, five died of toxæmia and cardiac failure, with basal congestion and broncho-pneumonia in varying degrees, seven, three, eleven, five, and seven days after admission respectively. These cases in this order had two, one, two, three, and two injections of vaccine, and I doubt if it had any influence on them at all. Of the other four fatal cases one got steadily worse and died of perforation eleven days after admission, and vaccine possibly did harm in this case. Perforation occurred the day after the second dose. Another case became steadily worse, having two severe hæmorrhages after the injection, and died thirteen days after admission; and here also vaccine possibly did harm, as the case was admitted early in its course and the bleeding occurred on the tenth and eleventh days (*see* Case 162).

Another case died of hæmorrhage thirty-six hours after admission, having arrived in a collapsed condition as a result of severe bleeding during the journey. A small dose of vaccine (100 millions) was given after he had revived, and the hæmorrhage recurred. I do not think vaccine did him harm, as no form of treatment could have saved him. In the remaining fatal case the temperature came down steadily after four doses of vaccine, but at the same time the pulse-rate and the delirium were bad, the patient was in a very asthenic condition, and he died fifteen days after admission of a rapidly spreading pneumonia.

Of the five survivors, in one vaccine certainly appeared to do good. Details of this case are given and it is one of those in which the temperature is no guide to the effect of vaccine (Case 112). In another the patient did not look as if he were going to pull through during his second week, but he began to get better after the third dose, and finally reached a normal temperature on the twenty-fourth day, which was rather soon considering the severity of the case, and I think vaccine may have benefited him. The other three cases all ran a severe and long course and all got rather worse after the first two or three doses of vaccine, and except for the fact that they did survive there is no reason to suppose that vaccine had a good effect, and one had a very tedious convalescence. Notes of these cases are given with a similar control case (Cases

111 and 8). The average length of the primary fever in the five surviving cases was thirty-one days.

(*b*) *Among the unvaccinated cases* there were ten deaths (71·4 per cent) and four recoveries. Of the fatal cases six died of toxæmia and cardiac failure with broncho-pneumonia eight, six, two, six, sixteen and thirteen days after admission, living on the average three days longer than the five similar vaccine cases. The four other deaths were due respectively to (α) hæmorrhage, (β) acute glomerular nephritis, (γ) acute gangrenous decubitus and septicæmia coming on twenty-one days after admission and lastly (δ) toxæmia associated with facial erysipelas. The four surviving unvaccinated cases were all critically ill during their course. Two in the end did very well and had an uninterrupted convalescence, and notes of one of these (Case 8) are given with a similar case on vaccine treatment (Case 111). The average length of the primary fever in the four surviving cases was thirty-six days. The effect of vaccine in this class may be summed up thus: In one case it certainly appeared to do good and it may have done good in another. In one case it did not have a fair chance. In one case it appeared to do harm and it possibly did harm in two others. In four it certainly did no good, and in the remaining five it cannot justly be said to have had an effect one way or the other. I do not think that a conclusion for or against should be drawn from a comparison of the mortality-rates as the total number of cases was small and in two of the non-vaccinated cases the cause of death was most unusual.

CHARTS.

[*Note.*—All cases are uninoculated patients unless otherwise stated. The *average* pulse and respiration rates for the day are noted. The figures against the arrows denote the amount of vaccine given in millions of bacilli.]

Case 112 (*Chart* 1).—On admission, eleventh day: Sallow complexion with malar flush, toxic. Dry, furred tongue. Regular pulse. Abdomen distended and tender. Feeble heart sounds. Lungs normal. Fourteenth day: Rapid, feeble pulse. Bad, sallow, toxic look, and muttering delirium. Twentieth day: Fall of temperature with profuse sweating. Pulse now good. Patient undistressed and sensible. Steadily improved from this day onwards.

Summary.—A very toxic severe case soon after admission (Class 1). Noticeable for quick improvement in mental symptoms and cardiac weakness. Apparently a good result for vaccine. Note

entire absence of pulmonary involvement. Blood culture showed *B. typhosus*.

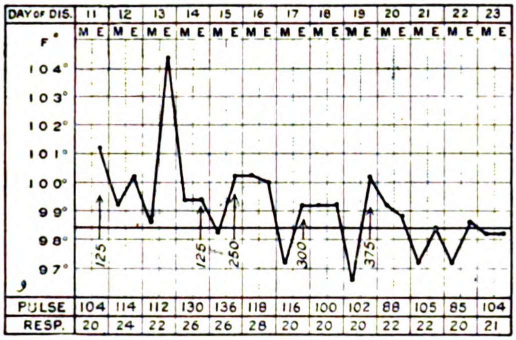

CHART 1.

Case 162 (*Chart* 2). — On admission, sixth day: Flushed, lethargic, inert. Typical appearance of acute toxic type with tendency to pseudo-pneumonia variety. Small, regular pulse. Distended soft abdomen. Diffuse coarse bronchitis. Blood culture showed *B. typhosus*. Ninth day: Voice lost. Distension marked, bronchitis marked. General condition the same. Fifteenth day: Rapid, poor pulse, mouth very dry. Very toxic.

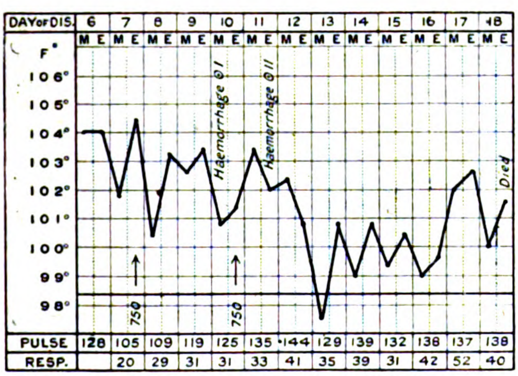

CHART 2.

Summary.—A typical very severe toxic case (Class 1). Vaccine possibly did harm, as patient got steadily more toxic, pulmonary involvement became worse, and he had two severe hæmorrhages in association with the injections.

Case 111 (*Chart* 3).—On admission, seventh day: Pinched and

flushed and looks ill, drowsy, and cannot remember. Pulse regular, but soft and dicrotic. Tongue has dry, brown fur. Abdomen full and moves badly. Slight bronchitis. Blood culture showed *B. typhosus*. Thirteenth day: Toxic and drowsy, tongue still dry, pulse poor, more distended. Twenty-third day: Very drowsy, poor pulse, cardiac weakness the chief danger, more bronchitis. Twenty-ninth day: Poor pulse, slight but steady general improvement. Slow convalescence owing to dilated heart with rapid pulse.

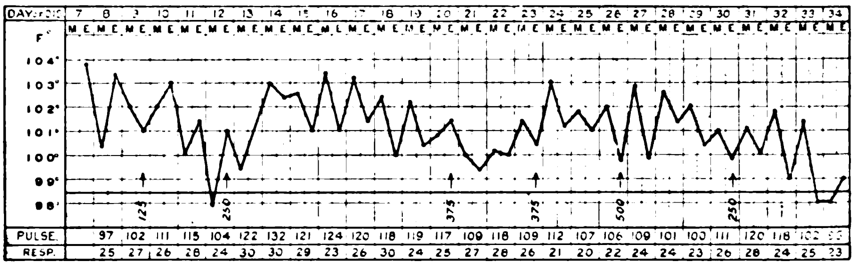

CHART 3.

Summary.—Typical severe toxic and prolonged case. Class 1. Did not look like pulling through at one time. Vaccine not thought to have had any definite effect. Note rise in temperature and pulse-rate after second dose. Compare with Case 8.

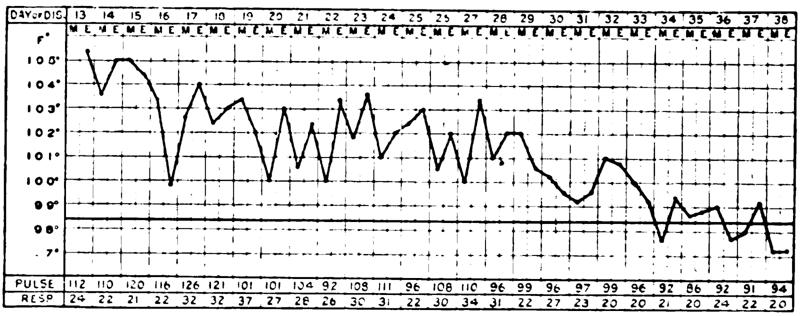

CHART 4.

Case 8 (*Chart* 4).—On admission, thirteenth day: Flushed; talks incoherently. Pulse soft and thready. Tongue dry and tremulous. Abdomen distended and tender. Much bronchitis. Blood culture showed *B. typhosus*. Eighteenth day: Better. Bronchitis seems the chief danger. Twenty-sixth day: More toxic in appearance.

Stools frequent and undigested. Pulse is steady and of better volume. Thirty-third day: No distension. Pulse fair. Does not look toxic. Slow, steady improvement from now onwards.

Summary.—Very severe, toxic and prolonged case, (Class 1), which has done very well in the end without vaccine. Compare with Case 111.

Case 0 (*Chart* "*A*").—On admission, eighth day: Looks ill and seems slightly delirious. Pulse of low tension but not dicrotic. Abdomen distended and slightly tender. Little or no bronchitis. Spleen felt, and large crop of large spots. Sent into hospital with culture from the blood stated to be *B. typhosus*. Tenth day: Delirious. Dry, brown, toxic tongue. Twelfth day: Improving. Not delirious. Fourteenth day: Markedly improved all round. Abdomen flaccid.

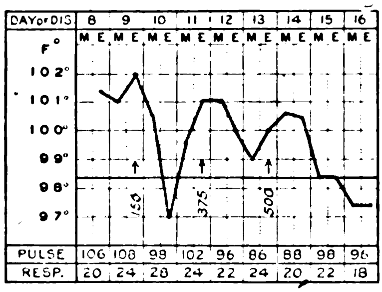

CHART "A."

Summary.—A severe typical toxic case. "Considered a good result for vaccine treatment, which markedly affected for the better both temperature and general condition" (quoted from notes made at time of patient's discharge from hospital). The culture obtained from the blood was subsequently further examined and gave quite definitely all the cultural reactions of the *B. paratyphosus* A, and also fulfilled the agglutination and absorption tests. It is rather a characteristic of paratyphoid cases to take a sudden turn for the better a few days after admission. The supposed "good result," therefore, was a fallacy.

Class 2.—Severe and toxic, 74 cases (37 treated with vaccine and 37 without).

(*a*) *Among the vaccinated cases* there were thirteen deaths (thirty-five per cent) and twenty-four recoveries. In six of the *fatal cases* one is not justified in saying that vaccine affected the result. The causes of death in these six cases were as follows:

Toxæmia and broncho-pneumonia in three cases; cellulitis and terminal septicæmia in one case; intestinal obstruction by adhesions resulting from a shut-off and healed perforation in one case; and lastly, toxæmia with, in addition, ulceration of the vocal cords and epiglottis, in one case. In two of the fatal cases vaccine certainly appeared to have a bad effect. In one of these (Case 159) the patient became worse in every way after four injections and died on the seventeenth day after admission. In the other fatal case vaccine was given on the thirtieth day to see if it would stimulate the patient to finish off a long course, and this single dose was followed by fatal hæmorrhages (Case 164). In the five remaining fatal cases there is a strong suspicion that the vaccine was harmful. In one the vaccine was given a good chance as he had seven injections, but he slowly and steadily became worse, and perforation finally occurred twenty-two days after admission. The second, who had five injections, died of toxæmia and pulmonary congestion fourteen days after admission. The third died in three days of hæmorrhage commencing thirty-six hours after an injection of 250 millions. In the fourth case death occurred from toxæmia and broncho-pneumonia, but he had some hæmorrhage following on two doses of vaccine. The fifth of these cases died also of toxæmia and lung involvement, but he had become more delirious and altogether worse after two injections.

Of the twenty-four *recoveries*, two certainly appeared to have been benefited by the vaccine, that is to say, not only did they do well and quickly, but much more so than might have been expected, considering their severe condition on admission (Case 117). Another case appeared to have done unusually well, but had a severe relapse, and therefore cannot be considered a good result for vaccine. In one case vaccine was only given in a relapse, and as this was quite short it may have done good in this way. In four other cases it may possibly have been beneficial, as they all did fairly well and made a good convalescence. Eight of the cases ran a severe and rather long course, but this was no more than might have been expected, and one cannot say that vaccine affected them one way or the other (Case 114 and Case 177). In one case the vaccine was stopped after two injections, as the patient was doing badly owing to severe involvement of the lungs. In six of the cases vaccine appeared to do harm, as although it was thoroughly tried, all these cases had long courses (two of over eighty days) which were associated with great weakness, wasting, and other complications. The average day of the disease

on which the temperature first settled was the thirty-sixth, whereas in the controls it was the twenty-seventh day.

(*b*) In the *non-vaccinated* cases there were ten deaths (twenty-seven per cent) and twenty-seven recoveries. Six of the fatal cases died of toxæmia and broncho-pneumonia, with a course similar to that of the vaccinated cases of this type. One of the six had a severe and one a slight hæmorrhage.

Two cases died of perforation. In one of these the perforation did not occur till about the seventh week of the disease, and the other one had a hæmorrhage preceding the perforation. One case which had suppurating parotitis died of a confluent broncho-pneumonia. The remaining fatal case had thrombosis of the left femoral and the external iliac vein, and finally died as the result of pulmonary infarct and pleurisy.

Of the twenty-seven recoveries, ten ran the usual course of such cases, nearly all of these making a good convalescence. Two cases did remarkably well considering their apparent severity on admission. Details of these cases are given, as, had they been given vaccine they would have appeared good results for this treatment (Cases 32 and 23). Two cases ran a course worse than the average, one being very prolonged and complicated by hæmorrhage, parotitis and pyelitis, and the other was prolonged for six weeks but without complications. Of the remainder, six patients did rather better than usual and had no complications or sequelæ, whereas eight others did rather worse than usual and all had one or more complications.

Summary of this Class.—I wish to draw particular attention to this class of a test of vaccine, because, whereas in Class 1 the prognosis is bad, and in Classes 3, 4, and 5 fair to very good, it is in Class 2 that the prognosis is doubtful. It was hoped that in this class vaccine treatment might be found to turn the balance. It will be seen from the above analysis that this is not so. The mortality-rate is not lowered, neither is the incidence of relapses or complications lessened by this stock vaccine. Also, the average cases which did well with vaccine ran a course very much the same as the average case which did well without it, and the cases which did exceptionally well in either group are balanced by such cases in the other. Finally, the average length of the primary period of pyrexia in the vaccine-treated was longer by nine days than that of these cases which had received no vaccine.

Case 159 (*Chart* 5).—On admission, tenth day : Looks toxic but quite sensible. Pulse soft and dicrotic. Abdomen slightly distended

and generally tender. Bronchitis both bases. Blood culture gave *B. typhosus*. Thirteenth day: Delirious. Bases congested and broncho-pneumonia of influenzal type. Fifteenth day: Rigor followed vaccine. General condition is not so good, he is more delirious and abdomen is more distended. Twentieth day: Vaccine given at 7 p.m. last night. At 3 a.m. this morning much worse, temperature rose to 105° F. and pulse to 150. Is now very toxic, with widely dilated pupils. Patient continued very toxic, and finally died of exhaustion.

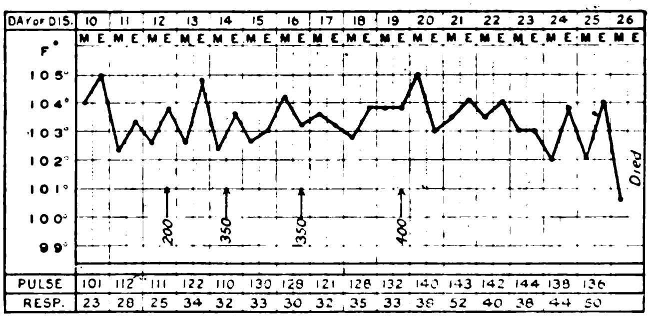

CHART 5.

Summary.—A severe case (Class 2) which got decidedly more toxic while on vaccine. Vaccine certainly appeared to do harm, as patient was worse after each individual dose.

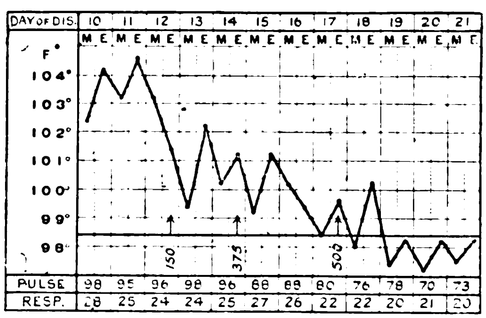

CHART 6.

Case 117 (*Chart* 6).—On admission, tenth day: Looks rather toxic, but mental condition is clear. Pulse is soft but not dicrotic. Abdomen distended and slightly tender. Heart sounds good. Much big tube bronchitis. Thirteenth day:. Toxic and delirious and trying

to get out of bed. Blood culture gave *B. typhosus*. Fifteenth day: Decidedly better. Tongue moistening. Profuse crop of spots all over body. Continued to make rapid progress.

Summary.—A rather severe and decidedly toxic case (Class 2) which has done remarkably well and rapidly and is apparently a good result for vaccine, but the absence of severe pulmonary involvement and the comparatively slow pulse throughout suggested a fairly good prognosis.

Case 114 (*Chart* 7).—On admission, thirteenth day: Pale. Mentally clear when roused. Small, regular pulse. "Beefy" tongue. Abdomen not distended. Spots are very numerous. No bronchitis. Blood culture gave *B. typhosus*. Thirteenth day: Rapid, poor, irregular pulse. Looks toxic. Twenty-first day: Pulse better. Shows all-round improvement (? *post* or *propter* vaccine). Twenty-fifth day: General improvement continues, but temperature chart not affected. Thirtieth day: Continues doing well. Quite undistressed. Abdomen hollowed. Temperature as before. Thirty-eighth day: Doing well, but looks pinched and is very wasted.

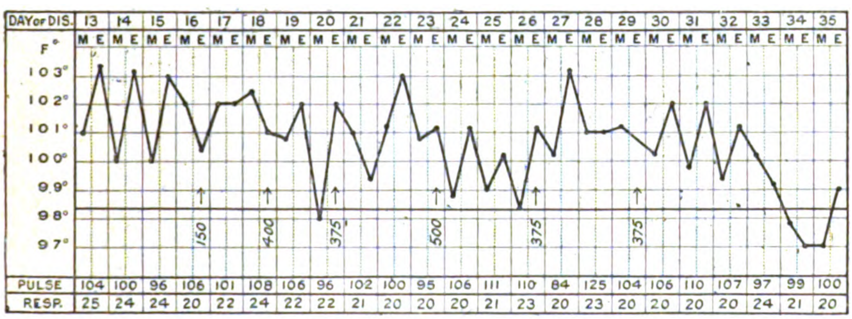

CHART 7.

Summary.—A typical severe case (Class 2), marked by myocardial weakness. Final result good. There does not appear to be much evidence, however, that vaccine did any good. Case was prolonged and temperature was irregular independently of the vaccine. An example of several similar cases.

Case 32 (*Chart* 8).—On admission, seventh day: Toxic, flushed, incoherent, and later had muttering delirium. Regular, good pulse, not dicrotic. Tongue is dry with brown fur. Abdomen full. Respirations rapid, but no moist sounds in chest. Blood culture not done. Widal reaction, negative. Eighth day: Restless, delirious and noisy. Flushed and toxic. Tenth day: Remarkable change.

No delirium. Does not look toxic and is at his ease. Widal reaction positive to *B. typhosus*. Patient went straight ahead to make an uninterrupted recovery.

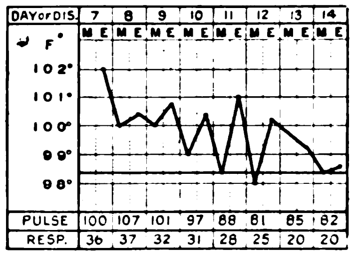

CHART 8.

Summary.—Appeared a typical severe and very toxic case (Class 2). Made a remarkably good and rapid recovery. If vaccine had been given would undoubtedly have been thought a good result for this treatment, and the case therefore should be compared with Case 117.

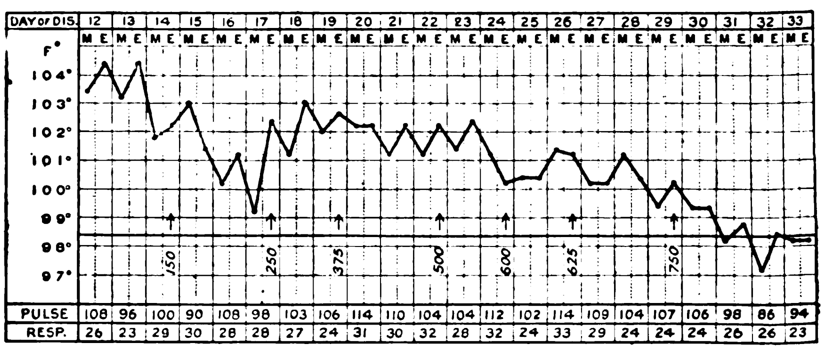

CHART 9.

Case 177 (*Chart* 9).—On admission, fourteenth day: Flushed, toxic and delirious, picking at bed-clothes and very talkative. Pulse is full and bounding, but dicrotic. Tongue, dry brown fur. Abdomen distended. Coarse bronchitis. Blood culture negative. Agglutination positive to *B. typhosus*. Eighteenth day: Flushed. Still a little delirious. Temperature fell, but general condition was not altered. Twenty-fourth day: Quieter the last few days and is now definitely improving. Thirtieth day: Slow improvement. Mental condition poor and he is frequently incontinent. Vaccine seems to have no effect. Despite big dose there is no local or

general reaction. Thirty-second day: Slow general improvement from now onwards, but mental condition did not recover for another ten days.

Summary.—A severe toxic case (Class 2), with mental weakness. Pyrexia prolonged to end of fifth week. Ultimate result good. Had seven injections of vaccine, which certainly did not shorten case, and it is doubtful whether vaccine had effect. Case is shown as an example of many similar cases which eventually did well but in which vaccine appeared to have no definite effect.

Case 23 (*Chart* 10).—On admission, eighteenth day: Flushed; looks toxic; laboured breathing. Pulse of big volume but soft. Abdomen not at all distended. No moist sounds, although slightly cyanosed and breathing deeply. Twenty-first day: Much better all round and has lost his toxic look. Went ahead rapidly after this. Blood culture before admission reported as *B. typhosus*. Blood culture was negative here, but agglutination reactions strong with *B. typhosus*.

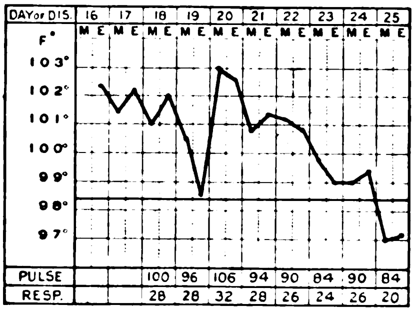

CHART 10.

Summary.—Typical toxic and apparently severe case (Class 2) on admission, which rapidly improved in an unexpected manner without vaccine and made a rapid convalescence. Case is shown as an example of several which, if they had received vaccine, would have been thought good results.

Case 124 (*Chart* 11).—On admission, eleventh day: Sallow, with slight malar flush. Lethargic, but clear mentally when roused. Regular good volume soft dicrotic pulse. Normal abdomen and no moist sounds in chest. Blood culture negative. Stool of thirteenth day contained *B. typhosus*.

Summary.—A case which looked moderately severe (Class 4), but with an excellent prognosis. Improved very rapidly, but had a

relapse. Case is shown as one of the few in which each individual dose of vaccine appeared to have a marked effect both on temperature and general condition.

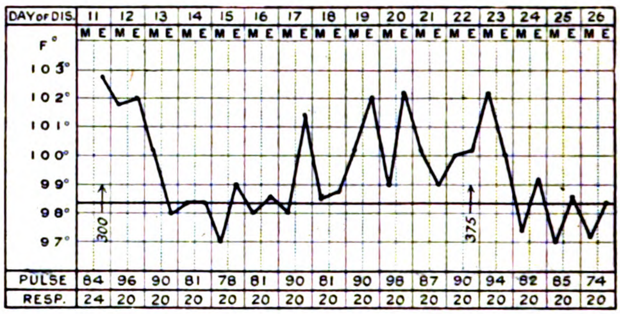

CHART 11.

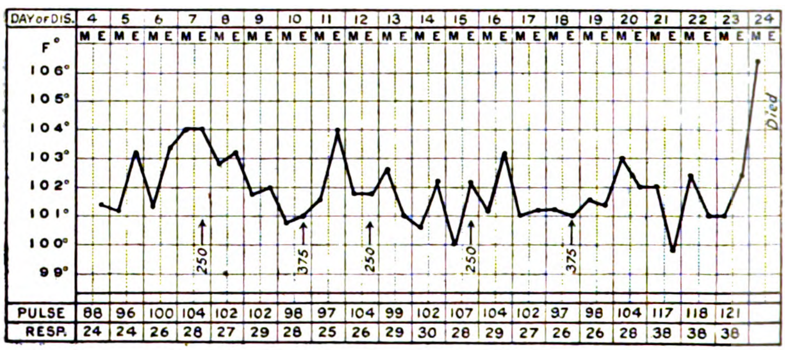

CHART 12.

Case 140 (*Chart* 12).—On admission, seventh day: Pale and looks ill. Lethargic, but quite clear when roused. Big volume, but very soft and dicrotic pulse. Abdomen is not distended. No moist sounds heard in chest. Blood culture, *B. typhosus* found. Fourteenth day: For the first few days was bright in the mornings and could read the paper. Is now getting a little more toxic. Wanders at night. Abdomen now tumid. Pulse good and rarely above 100. Eighteenth day: Continuous as above. Sleeping draught required at night. Tongue now quite dry and typical. Pulse soft and dicrotic. Is now rather a severe case. Twentieth day: Very restless. Is distended and has diarrhœa. Heart is getting dilated. Twenty-third day: Heart shows cantering rhythm. Tubular breathing left lower lobe, but rapid respiration mostly toxic. Seems to be going downhill with cardiac weakness asso-

ciated with a steadily increasing and now severe toxæmia. Vaccine quite useless (? has increased toxæmia).

Summary.—A typical slightly toxic and moderately severe case (Class 3)—*vide* pulse-rate, respiration-rate, absence of distension, etc., on admission. Patient had the appearance of one likely to do well, and vaccine therefore undoubtedly appeared to do harm.

Classes 3 and 4.—Moderately severe and slightly toxic or not toxic; 88 cases (44 treated with vaccine and 44 without).

These two classes of case are considered together as they form degrees of the same kind of case in which the prognosis varies from "good" to "very good." It is especially in this class of case that a good effect of vaccine is difficult to judge, as all are likely to do well, and vaccine is therefore liable to get undeserved credit unless the unvaccinated controls are considered. The statistics of the control cases must be carefully examined (*see* table below), and it will then be seen that the effect of vaccine in so far as it has a good influence is practically negligible.

(*a*) In five of the *vaccinated cases* there did certainly appear to be an effect on the case as a whole, and in one each injection seemed to have a marked effect (Case 124). But cases of a similar nature may occur without vaccine treatment. In ten other cases vaccine may have shortened the fever and therefore may have done good in these. In one fatal case it certainly appeared to do harm, as this patient was neither very severe nor toxic, and yet he got progressively worse while on vaccine, and died of toxæmia and cardiac failure (Case 140). In the other fatal case who had vaccine death was due to sudden hæmorrhage on the seventeenth day of disease following on a dose of vaccine. There was, however, just such a case of fatal hæmorrhage occurring on the eighteenth day of disease in one of the controls. Vaccine may have been the decisive factor, but the hæmorrhage may thus have been a coincidence. In five other cases the course was long or otherwise worse than the average, and vaccine may possibily have done harm to these. In the remaining twenty-two cases the patients did well, but just as might have been expected, and I do not think vaccine affected them either way.

(*b*) In the *forty-four unvaccinated cases* there were also two deaths. One already referred to died of hæmorrhage, and the other also had hæmorrhage, but died with increasing severity and toxæmia. The great majority of the cases ran the course that was expected. The average length of fever in the vaccinated and unvaccinated cases of these classes was about the same, and is shown, together

Two Hundred Uninoculated Cases.

Statistics of the Five Classes with and without Vaccine, and of the Total 200.

	Class 1		Class 2		Class 3		Class 4		Class 5		Percentage or average in		
											Total 200	100 on vaccine	100 no vaccine
With (+) or without (0) vaccine	+	0	+	0	+	0	+	0	+	0	..	+	0
Total number in class	14	14	37	37	24	24	20	20	5	5	200·0	100·0	100·0
Mortality	9*a*	10	15	10	1	2	1	0	(1)	0	23·5	25·0	22·0
Length (days) of primary fever	31	36	36·4	27·7	26·2	27·7	25·3	22·1	23·5	14·4	27·5 days	29·0 days	26·0 days.
Total number of cases having one or more complications of any kind, viz., or sequelæ	6	6	21	23	14	14	7	6	3	1	50·5	51·0	50·0
Relapses	–	–	3	3	4	4	2	2	1	–	9·5	10·0	9·0
Hæmorrhage[1]	2	1	9	6	2	3	2	1	–	–	12·5	15·0	10·0
Perforation	1	0	2	2	–	–	–	–	–	–	2·5	3·0	2·0
Thrombosis	–	–	–	1*b*	–	–	1	–	–	–	1·0	1·0	1·0
Phlebitis	–	–	1	–	2	1	–	–	–	–	2·0	3·0	1·0
Slight rises in temperature in convalescence[2]	2	1	3	3	4	2	3	1	–	1	10·0	12·0	8·0
Tachycardia in convalescence	1	2	2	4	3	4	1	2	1	0	10·0	8·0	12·0
Pleurisy	–	–	1	–	1	1	–	2	–	–	2·5	2·0	3·0
Otorrhœa	–	–	1	1	–	1	–	–	–	–	1·5	1·0	2·0
Marked wasting with bed-sores	–	–	3	1	–	–	–	–	–	–	2·0	3·0	1·0
Parotitis	–	–	1*c*	4*d*	–	–	–	–	–	–	2·5	1·0	4·0
Laryngitis[3]	–	–	1	–	1*e*	1	–	–	–	–	1·5	2·0	1·0
Other complications or sequelæ	1	4*i*	3	5*h*	1*f*	2*g*	–	2	–	1	9·5	5·0	14·0
Prolonged convalescence from severe debility and other causes not mentioned	1	2	12	11	3	0	2	0	–	–	15·0	18·0	13·0

[1] Was the cause of, or was associated with, death in six vaccinated cases and five unvaccinated.
[2] By this is meant evanescent rises of temperature which are not relapses and which are not associated with a complication or sequelæ.
[3] Only cases in which there were destructive changes in the larynx are included (sore throat, &c., not necessarily included).

a, One death in a case admitted in a dying condition.
b, The supposed cause of a pulmonary infarct (fatal).
c, With abscess formation.
d, Two with abscess and two without.
e, Ulceration followed by cicatrization requiring tracheotomy.
f, Temporary insanity.
g, Tonsillitis.
h, Includes one case of biliary colic and jaundice.
i, Includes one case of septicæmia and endocarditis (fatal), and one case of glomerular nephritis (fatal).

with the incidence of complications and sequelæ, in the subjoined table.

Class 5.—Very mild, 10 cases (5 treated with and 5 without vaccine).

One death occurred in this class in a man who had a severe relapse (?) and prolonged fever, after what appeared to be a very mild preliminary attack. It was only when in this acute stage that he had vaccine, and the death is therefore in brackets in the comparative tables. Two vaccinated cases ran an unusually long course, and it should be noted that the average length of fever in the vaccine-treated cases was much longer than in those which did not receive it. As the numbers are small one can only say that in this class the vaccine did not appear to have any good effect.

The Inoculated Cases.—There are thirty of these, half being treated with vaccine. They had all been inoculated once or twice during the nine months preceding their illness. The *B. typhosus* was isolated from each. As the number in each series is small, I do not think that much can be deduced from the statistics. The more important facts are set out in the following table:—

With (+) or without (*0*) vaccine	Class 1		Class 2		Class 3		Class 4		Class 5	
	+	*0*	+	*0*	+	*0*	+	*0*	+	*0*
Number of cases in class	2	2	6	6	4	4	2	2	1	1
Mortality	2	..	2	1	–	–	–	–	–	–
Average length of fever in days ..	–	255	35	27	25	27	25	28	21	23
Hæmorrhage	1	–	1	1	–	1	–	–	–	–
Perforation	1	–	1	–	–	–	–	–	–	–
Relapse	1	–	–	–	1	–	–	–	–	–
Prolonged convalescence	–	1	–	–	1	–	–	–	–	–
Thrombosis	–	–	–	–	1	–	–	–	–	–

It will be seen that in the above fifteen cases vaccine had no good effect on the mortality or on the incidence of complications, I do not think that one can say that it definitely had a bad effect on the cases, as a whole, as the numbers are small. One outstanding fact, however, is that the average length of fever amongst the vaccinated cases of Class 2 (the largest class) was much longer than that of those in this class which had no vaccine.

One of the cases of Class 1 which died was admitted in a critical condition with a subnormal temperature. He had one injection, after which the temperature steadily rose, and he died thirty-six hours afterwards. In the other fatal case of this Class the temperature took six weeks to reach normal; the patient then had a relapse, during which he died from perforation of an old

ulcer. Of the two fatal vaccinated cases of Class 2 one died of perforation after three injections, and the other died of a confluent broncho-pneumonia, being then in a very asthenic state with a subnormal temperature. There was no case among the series receiving vaccine which did markedly better than any of the control cases.

In none of the four cases which were given the serum-treated vaccine is there any reason to suppose that the course was definitely affected. One of the cases died of toxæmia. It was a severe, prolonged case, and the serum-treated vaccine was given late in the disease to see if it could stimulate the patient to further efforts, but without effect.

Summary and Conclusions.

In the total vaccinated cases there were twenty-nine in which it appeared that vaccine had a definite good influence. Of these, twenty belonged to Classes 3 and 4, i.e., to those classes in which the prognosis is good. In other words, "good results" are more often obtained where good results can be expected by ordinary methods of treatment alone. On the other hand, the mortality rate and the average length of fever in these classes was slightly worse among the cases who had vaccine.

Among the cases belonging to Classes 1 and 2, in which the vaccine appeared to do good, none had severe lung involvement. Those cases which had much bronchitis or broncho-pneumonia (the average severe case) ran the severe course which is usual, and vaccine appeared to be of no avail. To say that, if the average severity of the cases treated had been less, the vaccine would have had better results, is merely to say, I think, that the cases would then have done better anyhow. From all this it would appear: (*a*) That it is in just those cases in which the physician so much requires help that vaccine is so disappointing; (*b*) that vaccine neither shortens the fever nor reduces the number of complications in even that class of case which is likely to do well; (*c*) that there is a decided suspicion that vaccine increases the incidence of hæmorrhage.

The conclusion, therefore, is that the use of a stock vaccine in typhoid fever cannot be recommended as a routine treatment. I should add that these conclusions are largely contrary to the impressions which I received during the treatment of the earlier cases. I had not then seen a sufficient number of similar cases which did well without vaccine, and being rather biased in its favour, I gave undeserved credit to this treatment.

NEPHRITIS IN THE BRITISH TROOPS IN FLANDERS.[1]
A PRELIMINARY NOTE.

By Sir JOHN ROSE BRADFORD, K.C.M.G., C.B.

During the earlier months of the campaign the number of cases of nephritis seen in the base hospitals was remarkably small, and in a group of such hospitals under my observation, where there were several thousand beds, I only saw, at this period, a few isolated cases of no great clinical interest. These were principally cases of chronic renal disease in men who had rejoined the army from the reserve, and where, under the stress of the campaign, the chronic malady had progressed more rapidly than usual, or where recrudescence of an old renal lesion occurred. These cases presented obvious physical signs of cardio-vascular changes such as high tension and arterial degeneration, and often other physical signs of chronic renal disease, e.g., the anæmia and such retinal changes as albuminuric retinitis. One of the most striking features of the medical cases admitted to hospital in the autumn and winter of 1914 was the rarity of renal dropsy. During this period, however, other maladies commonly reputed to be due to, or associated with, exposure to inclement weather were by no means rare. Thus, bronchitis and other pulmonary affections were prevalent, and there were also numerous cases of enteritis and colitis. Further, during the wet and cold winter months, very large numbers of men were admitted with the so-called "trench foot" resulting from exposure to cold and wet in the trenches. Even during this period, when the climatic conditions were very unfavourable owing to long-continued cold rain, and the hardships suffered by the troops were considerable, there was, so far as my experience went, no considerable number of cases of nephritis accompanied by obvious renal dropsy. Speaking generally, it may be said that the cases of nephritis were few in number until the months of March and April, 1915. In these two months far more cases were admitted to hospital than the total admissions for the whole period of the War up to that date. The April admissions were greater in number than those of March, and the April admissions alone were not far short of the total admissions for the whole duration of the War to April. Further, if only the

[1] Reprinted from *Quarterly Journal of Medicine*, vol. ix, No. 34, January, 1916.

admissions from the troops that had been at the front since the commencement of the War were taken into account, the same conclusion is arrived at—the incidence of the disease in March and April in these divisions is in marked excess to what obtained in the same divisions in the earlier months. Hence it is quite certain that the increase in the number of cases of nephritis was not due merely to the increase in the numbers of the British troops in the field in the later months, as compared with the numbers in the earlier months. It is impossible for several reasons to give the actual numbers in this preliminary communication, but not only in the early spring but also in the summer the increase in the nephritis cases was far greater relatively than the increase in the number of the troops in the field. Further, emphasis must be laid on the fact that not only did a great increase in the number of cases occur in the spring, i.e., in March and April, as compared with the earlier months, but the cases were also of a different type. Cases were now seen in large numbers with typical renal dropsy in so far as its distribution was concerned, and, as mentioned above, dropsical cases had been quite rare up to that time.

It may therefore be said that this outbreak of nephritis occurred in the spring of 1915, especially in March and April; the number of cases admitted increased still further in later months, and the occurrence of these cases has persisted until the present time with some fluctuations. The incidence was especially high in the summer months of 1915, but owing to increases in the strength of the forces in the field it is not possible at present to speak with certainty as to the actual case incidence. Again, during the later months more attention has been directed to the occurrence of the malady, more hospitals and further facilities for examination both at the front and at the bases have been provided, and hence the disease is doubtless more often recognized, especially in its slighter forms, owing to more thorough examination of cases of illness.

A special case-sheet was drawn up and issued, and all cases diagnosed as "nephritis" were entered on such sheets, and the present preliminary paper is the result of a study of these case-sheets dealing with 1,455 cases under treatment at various periods since the outbreak in all the base hospitals of the Expeditionary Force in France. Further, at one of the bases all the cases of nephritis were segregated in one hospital, and these cases were seen repeatedly by me, and I also saw large numbers of cases in hospitals at other bases, so that in addition to the study of the case-sheets I have seen clinically some hundreds of cases. It is not

possible to make such detailed and thorough examination of the cases in the hospitals with the forces in France, as is possible in the base hospitals in England, but some few points of clinical interest have emerged in the work here and form the substance of this communication. It is hoped that a more detailed analysis of the cases may be made later. When the early cases were first observed, two prominent symptoms attracted notice, the occurrence of œdema and the presence of dyspnœa. Often the soldier stated that the onset of the dropsy was quite sudden, absent on one day and very markedly present the next, and attracting the attention of his fellows. Not uncommonly the first sign of illness was the presence of dyspnœa, and, so far as my observations went, many men complained especially of nocturnal dyspnœa. This was quite a marked feature of the onset and sometimes it persisted in a lesser degree for a few days. Others complained of dyspnœa on exertion, e.g., on the march. Objective dyspnœa was not, however, a very marked feature of the majority of the cases clinically, when the patients came under observation in base hospitals—always several days after the onset of the illness. In some of the earlier observations, although albuminuria was present, casts were said to be absent, and this at one time gave rise to doubts in the minds of some observers as to the real nature of the dropsy. More extended observation has shown, however, that casts are very frequently present, and it is probable for several reasons that the precentage of cases in which the urine contains casts is really much greater than appears at first sight. In a series of 1,455 cases, casts were present in 794 cases, they were stated to be absent in 507 cases, and were not looked for in 154 cases.

The present paper will deal only with a series of 571 cases where casts were found to be present, although many of the statements made would apply to cases where casts were absent. I have thought it better not to include such cases, as doubts might be raised as to the accuracy of the diagnosis of nephritis in such instances. In the great majority of the 571 cases the casts were of the hyaline and granular varieties. In some, however, hyaline casts only are noted. In a considerable number, epithelial casts are also recorded as present. In most cases where casts were present they were readily found, and it was not infrequent for them to be present in abundance—this was especially the case with granular and hyaline casts. Blood corpuscles were also frequently found, but definite blood casts are not often recorded. White blood-cells are of course frequently found. In some

instances, especially if the case is seen early, the urine is definitely smoky, and in others, but not in many, it may contain a large quantity of blood, so as to be obviously red to the eye. The latter condition, I would say from my own observations, is exceptional. Such cases present a rather different clinical picture to the general run of cases, in that with them dropsy is neither so frequent nor when present so marked a feature of the case.

Further, these hæmorrhagic cases more frequently have pyrexia and resemble much more closely in their course infective nephritis dependent upon some microbic invasion. In some instances of this type of case the *Bacillus coli communis* has been recovered from the urine. In a few instances the hæmaturia and pyrexia have been intermittent and recurrent, producing a clinical picture closely resembling that seen in renal embolism; but these patients have not been suffering from any condition liable to cause embolism, and have presented no physical signs justifying such a diagnosis, and it seems more probable that the condition is due to some bacillary infection. These cases, however, are few in number and are quite different from the ordinary form of nephritis with which this communication deals, and where dropsy is really the dominant physical sign; in these cases any considerable amount of blood in the urine is decidedly exceptional. The quantity of urine is notably decreased in all cases where dropsy is present, and especially so in the earlier stages of the malady whilst the dropsy is increasing. Quantities less than twenty ounces in the twenty-four hours are not uncommon, and it is not unusual for a greater degree of suppression of the urinary flow to occur during short periods. In some cases complete suppression for periods of twelve to twenty-four hours has been observed, and in such cases it is usual for uræmic manifestations of considerable severity to be present. Even in these very severe cases it is most exceptional for death to take place. More often the suppression only lasts a few hours, and the urinary flow is fully re-established in twenty-four to forty-eight hours. Only three fatal cases have fallen under my direct observation in a series of several hundred cases of nephritis, and in all these suppression, together with uræmia, occurred, but none of these three fatal cases was really a case of simple nephritis. In one the condition was really the terminal stage of chronic Bright's disease which had run a more or less latent course and was only recognized in its last stage when uræmia had occurred. In the second case, which presented clinically the picture of an acute simple nephritis with dropsy, and

where fatal uræmia ensued, post-mortem examination revealed the presence of congenitally malformed, atrophied, and hydronephritic kidneys with dilated ureters. Here the nephritis was implanted on kidneys already much impaired by a congenital lesion. In the third case it was found on post-mortem examination that one kidney only was present, the absence of the second was due here also to a congenital anomaly, and the one kidney present was deformed, either as the result of the atrophy of a portion of its substance as the result of an old infarct, or possibly congenitally. In this case also the nephritis had affected a kidney already impaired.

In all the other cases under my observation where suppression of varying degrees of severity developed, the patient recovered from any uræmic phenomena present and was ultimately well enough to be evacuated to England. It may be stated here that these three deaths are the only ones that occurred amongst the cases under my direct observation.

Dropsy occurs in the great majority of cases and is usually well marked, and, as mentioned above, it is, in a large proportion of cases, the initial phenomenon that leads the soldier to seek medical advice. The dropsy may first attract attention by affecting the face, the patient giving the usual history of not being able to open his eyes in the morning, or not infrequently the dropsy is first noticed in the legs. Some of the patients complained greatly of the swelling of the abdomen, and anasarca of the abdominal wall was often well marked. Ascites, usually only of moderate degree, was present in a certain number of cases, but so far as my own observations went, it was not present in the bulk of the cases, and when present was never large in amount, and no case calling for paracentesis abdominis occurred. Much of the swelling of the abdomen complained of by the patients was really due to the œdema of the parietes. Œdema of the scrotum was not uncommon, and the well-known cushion of œdema over the sacrum and loins, so often seen in kidney disease, also occurred, but it was very exceptional for the dropsy to develop to the extent that is so often seen in nephritis in civil practice. Hydrothorax has occurred, but only in a very few instances, and pulmonary œdema with marked physical signs has been observed not only in the cases with severe uræmic manifestations, but also in slighter degree in other cases with far less urgent symptoms of uræmia.

In all the above points, the dropsy seen in these cases of nephritis resembles very closely the nephritis as seen in civil

practice. Thus it is most marked in the subcutaneous tissue and is prone to affect the face, scrotum, sacrum, and loins, and when marked to be accompanied with some collection of fluid in the great serous cavities, especially the peritoneum, and, finally, pulmonary œdema is not infrequent. There are, however, as far as my experience goes, certain points of difference. The most striking is the transitory duration of the dropsy; in some cases it might more properly be described as evanescent, as it may last only some two or three days. In a very large proportion of the cases, it does not persist for more than a week or ten days. There are some cases, but not a large number, where it is more persistent, lasting several weeks, but then there is nothing to distinguish such cases from those that every physician is familiar with in civil practice. The point of main clinical interest in the nephritis as seen in the hospitals in the field, is that large numbers of cases are seen where, notwithstanding the fact that the dropsy is quite marked in amount, it disappears rapidly with the most simple treatment. It is exceptional for it to be still present a fortnight after the onset, and it is only in a quite small proportion of cases that the dropsy resembles in its clinical course the form seen to accompany acute nephritis in civil practice.

It is remarkable, seeing the very large number of cases that have occurred, that the well-known facies of acute renal disease is so exceptional. The pale waxy or pasty swollen face so often seen in acute nephritis is, I would say, quite exceptional; this peculiarity may perhaps be associated with, or due to, the short duration of the dropsy. Further, although the dropsy is quite marked and obvious, I have seen no case where it was extreme in amount, and no case where any special methods of treatment, such as puncture, were necessary for its relief. This also is rather remarkable seeing the considerable number of cases that have come under observation. Lastly, no complications—such as secondary infections of the œdematous legs, gangrene, etc.—have come under my observation.

The dropsy accompanying this form of nephritis may therefore be said to be very frequent, the great majority of the cases suffering from it; it is marked in amount but never extreme. It is remarkable for its comparatively short duration and for not being accompanied with the marked anæmia and cachexia so usual in renal disease.

The albuminuria varied greatly in amount, especially as many of the observations were made on single casual specimens and not on a twenty-four hours' sample. Usually the amount present was

very considerable, and in some cases the urine became solid on boiling. This was exceptional, and more usually an estimate formed by observing the amount of coagulum after boiling, and subsequent standing of the urine would yield a result showing the presence of from a quarter to two-thirds albumin by volume in the more severe cases. In a very considerable number of cases the amount was far less, and was described by the medical officer as a "cloud," or a "dense cloud." The amount of albumin was sometimes small even when dropsy was present, but generally, when the albuminuria was slight, the dropsy was also slight or absent. Not infrequently the patient reached the base hospital when the dropsy had subsided and when the urinary flow was re-establishsd, and these cases often presented a lesser degree of albuminuria, since the nephritis was really subsiding. Hence, it may be said that at the onset and during the height of the disease the albuminuria is considerable in amount and comparable to what is usually seen in the acute nephritis of civil practice. The albuminuria is much more persistent than the dropsy, and even in the cases where it disappears before the transference of the patient to England, it has usually lasted several weeks. The great bulk of the cases were, however, evacuated to England after the subsidence of the dropsy, and at a time when the urine still contained a variable quantity of albumin. It is not possible at the present time to speak with certainty as to the duration of the albuminuria, but the impression formed from the study of this large series of cases was that, in the great majority, the albuminuria was subsiding at the time of evacuation, and such reports as have as yet been received from England as to the subsequent history of these cases confirms this view, as the albumin is reported to have disappeared after a few weeks. It would seem, therefore, that in the majority of cases the nephritis subsides rapidly. Uræmic complications of varying degrees of severity are common, and sometimes they have been of great intensity. Many of the patients have a distinct urinous or ammoniacal odour, and in one case of only moderate severity the patient complained not only of headache, nausea, and dyspnœa, but also of a strong taste of ammonia in the mouth, this last symptom being the one that caused the most discomfort, and it was present within the first few days of illness, at a period when dropsy was present and the quantity of urine excreted daily amounted to thirty ounces. In this case the urine increased to fifty ounces with the subsidence of the dropsy, and with this increase the unpleasant taste disappeared rapidly, and no serious uræmic phenomena developed.

Apathy, slight drowsiness, and a subnormal temperature are the most usual uræmic symptoms present, together with headache and nausea. Vomiting of course occurs, but it is not usually severe, and it is quite exceptional to see cases with the severe vomiting that causes so much difficulty in the treatment of renal disease in civil practice. Epileptiform seizures of a considerable degree of severity are by no means rare, and on several occasions such attacks have occurred quite unexpectedly in the course of the malady, when the general condition of the patient did not suggest that such a serious complication was either imminent or probable. Such cases, however, often show a markedly increased pulse-tension, quite appreciable to the finger, and this increased tension subsides rapidly when the uræmic attack has passed off.

These epileptiform attacks occur in cases of the acute disease where there are no physical signs suggestive of old-standing or latent renal disease, and the fact that, notwithstanding their severity, the patient recovers is confirmatory evidence that they are not complications merely occurring in patients the subjects of chronic renal disease aggravated by a superimposed attack of acute nephritis. If this were the case, the prognosis would certainly be more grave. As already mentioned, three fatal cases have fallen under my observation, and in all of these death occurred from uræmia and old renal lesions were present, but the uræmia was of a different type, coma, dyspnœa, etc., being present. In the acute simple cases the epileptiform seizures occur suddenly, at a time when the patient is not markedly uræmic, or at any rate does not present symptoms of the more grave forms of uræmia. They resemble somewhat closely the attacks seen in eclampsia, and also from time to time those seen in ordinary acute nephritis. In one case transitory acute mania occurred after the seizure. Uræmic amaurosis was seen in one case; it was of a severe type and was accompanied with suppression. The suppression of urine, however, was transitory in its duration, and the next day with its disappearance the amaurosis also cleared up. Headache is a common symptom, and not infrequently it is severe, and is then usually accompanied with high tension. Although dyspnœa, as already mentioned, is of frequent occurrence as an early symptom, the more severe forms of uræmic dyspnœa, such as the well-known hissing type and Cheyne-Stokes breathing, do not occur. In some instances the dyspnœa, although not very marked in amount, has been accompanied by the physical signs of pulmonary œdema, and in a few cases the pulmonary œdema has been quite considerable

in degree. In such cases the physical signs of the œdema have been well-marked in the upper lobes of the lungs, but this is a well-known phenomenon of pulmonary œdema. No case of death from pulmonary œdema has come under my notice.

In one case extreme dyspnœa of the type known as "air-hunger," together with drowsiness, was present, and the dyspnœa was so urgent as to suggest the presence of acetonæmia, but post-mortem examination revealed the existence of old-standing chronic renal disease. The kidneys were extremely atrophied and fibroid, and this case was merely one of uræmia in chronic renal disease and belonged, therefore, to quite a different group from that formed by the bulk of the acute cases now under consideration. Other uræmic phenomena, such as twitchings, cramps, and the various skin eruptions so common in renal disease, when uræmia is present, have not been present in the cases that have fallen under my observation.

Inflammatory complications, due to secondary infections, were decidedly rare in their occurrence. Bronchitis, however, was common, and in a series of 278 cases was present, either at the time of admission or during the short stay of the patient in a base hospital, in some thirty per cent of the cases. The more serious pulmonary complications, such as pleurisy and pneumonia, were rare, and no case of pericarditis, associated with nephritis, has fallen under my observation.

Observations on the fundus oculi have been made in a small proportion of the cases, but no changes of the fundus have been observed in the acute cases. In some of the cases of chronic disease that came under observation as apparent acute cases, the well-known phenomena of albuminuric retinitis were observed.

When the cases are reviewed as a whole, the following conclusions would seem to be justified.

Among the very large number of cases that come under observation, there are several distinct groups of cases.

First, there are some cases of ordinary chronic renal disease, of the type described as the granular kidneys, occurring amongst the older men. These cases present the ordinary clinical picture of the disease, so familiar to all—breathlessness, swelling of the legs, albuminuria—and yield evidence clinically in the heart and blood-vessels of marked cardio-vascular degeneration. Such cases are almost invariably men over thirty years of age, often much older, who have either rejoined the Army after following some civil occupation, or else they are some of the older men who joined the

Army soon after the commencement of the War. In many of these cases the chronic renal lesion was not necessarily very marked, and, as mentioned above, it is quite probable that under the stress of the campaign it has progressed more rapidly, or an acute nephritis may, in some instances, have been engrafted on the underlying chronic mischief.

Secondly, a group may be recognized, consisting, however, of only a few cases, where very serious chronic renal disease of long standing is present, but where the presence of the kidney disease has not been recognized owing to the absence of urgent symptoms prior to the onset of uremia. Such cases are seen from time to time in all varieties of practice, and hence it is not suprising that a few such cases should have occurred in the Army in the field. So far as I can judge, the number of such cases is extraordinarily small; I have not seen more than six, two of which were fatal, the others, although very ill, recovered sufficiently to be evacuated to England.

Thirdly, a group, also small in numbers, might perhaps be made where the clinical picture is essentially similar to that seen in the acute nephritis of civil practice. That is to say, the renal dropsy is much more persistent, as is also the marked albuminuria. Further, such cases develop the well-known anæmia and cachexia of acute Bright's disease.

The third group may be thought to be artificial, as it is possible that such cases are really only more severe samples of the typical cases that constitute the great bulk of the cases.

When these three groups are eliminated, the great bulk of the cases remain and seem to belong to one type, and to a type that, so far as my experience goes, is at any rate not common in civil life. The two outstanding features of the malady are the rapid subsidence of the dropsy and the remarkably low mortality when the severity of some of the uræmic attacks is taken into consideration. Renal dropsy does not usually subside in a week or ten days, and I only know of five deaths in a series of many hundred cases. In two of these the kidneys were abnormal congenitally, and in two old-standing chronic renal disease was present. In the remaining case a post-mortem examination was not made, so no statement of the exact condition can be made.

An attempt was made to gain further insight into the nature of these cases of nephritis by an analysis of 571 cases where casts were present. In sixty-two of these patients there was apparently a distinct history of a previous attack of renal disease. That is to say,

in 10·8 per cent of the cases the patient gave a history of a previous attack of dropsy similar to that present at the time of observation, or else stated that he had been in hospital or under treatment for "inflammation of the kidneys" or for "Bright's disease." Even if it is admitted that such statements were always reliable, eighty-nine per cent of the cases gave no such history. Previous renal disease can, therefore, scarcely be the cause of the malady in the majority of instances, although doubtless a previous attack of nephritis is a very important factor in the causation of any given attack of nephritis. It might be urged by some that these cases were really instances of acute nephritis occurring as a complication of slight old-standing lesions of the kidney; in other words, that the condition was really an acute exacerbation of slight chronic mischief. The fact that many of the earlier cases occurred among the older men gave some support to this hypothesis, and it is probable, I think, that this view is true for some cases, but not for any large number. If all the cases were examined by one observer, and by the same method, it might be possible to obtain a reliable result, but even then it is extremely difficult to differentiate clinically between a primary acute nephritis and one complicating a chronic lesion, unless the signs of the latter are unequivocal. Two cases have already been alluded to in this paper where clinically the diagnosis was confidently made of acute nephritis, yet the post-mortem showed the presence of congenital lesions—hydronephrosis and atrophy in one case, and a single kidney with marked fibrosis in the other, and the acute nephritis was superimposed on these chronic lesions. A considerable number of the cases have an accentuated aortic second sound, and a smaller number show distinct hardening of the radial artery. In a series of 149 cases, accentuation of the aortic sound was said to be present in thirty-nine per cent, and obvious increased tension in and hardening of the radial artery in twenty-seven per cent of the cases.

On the other hand, in the great majority of cases, there was no evidence either in the physical signs or in the patient's history to suggest the presence of a latent renal lesion. Further, the clinical cause of the malady, and more especially the rapid subsidence of the dropsy and the rapid disappearance of any anæmic complications, are not consonant with the suggestion of an acute nephritis complicating a chronic lesion of the kidney. Such complications are usually most formidable, protracted in their course, and frequently fatal, and it is interesting that, so far as my experience has gone, the fatal cases have shown chronic lesions in all where

post-mortem examinations were made. Another method, but an indirect one, available to try and reach a conclusion on this point is to study the age incidence. If the illness were due mainly to the nephritis affecting men with damaged kidneys, it might be expected that the bulk of the cases would be amongst the older men.

The age incidence in 571 cases where casts were present was as follows:

Under 20 yrs.	20-25 yrs.	25-30 yrs.	30-35 yrs.	35-40 yrs.	40-45 yrs.	45-50 yrs.
24 cases	123 cases	140 cases	126 cases	96 cases	40 cases	22 cases
4·2 %	21·5 %	24·5 %	22 %	16·8 %	7 %	3·8 %

Thus 25·7 per cent of the cases occur in men under 25 years of age, 50·2 per cent of cases in men under 30 years, and 72·2 per cent of cases in men under 35 years of age. Hence it is clear that large numbers of cases occur in quite young men. After 30 years of age there is a slight drop in the number of cases, and this drop becomes more marked after 35 years of age. In order to deduce really conclusive results, it would be necessary to know the number of men of the ages mentioned in the troops, as it is, of course, obvious that although only seven per cent of the cases occurred in men between 40 and 45 years of age, and nearly twenty-five per cent in men between 25 and 30 years, yet it is quite possible that the actual incidence of the malady was higher in the older than in the younger men, since the number of the older men in the ranks is probably very much less. It has not been possible to get any accurate information as to the age of the troops as a whole, but I am informed that the great bulk of the men are under 35 years of age.

The conclusions are probably warranted that the malady affects men of all ages, that young men are certainly affected in large numbers, and that possibly the actual case incidence may be higher in the older men, but the actual statistics available at the moment do not afford certain proof of this.

The men affected belong to all branches of the service, and although the great bulk of the cases have occurred in men at the front, the malady has been by no means limited to those actually serving in the trenches. Men serving in the Army Service Corps, and engaged in transport and supply duties, and men in the ammunition columns, have frequently suffered. Many of these men, although not actually serving in the trenches, have been engaged in duties involving much exposure to severe climatic conditions both by day and by night. Similarly a number of Royal Army Medical Corps orderlies at the Front have been affected. The disease has, however, not been limited to the men serving at

the Front, and has occurred amongst men serving entirely at the bases, who have never been to the Front. Further, there have been several cases affecting Royal Army Medical Corps orderlies whose duties have been confined entirely to base hospitals located in good buildings, where there has not been any question of exposure. In a series of 332 cases, 285 cases occurred in men serving at the Front, and 25 cases in men whose duties retained them at the base. In the remaining 22 cases no details of service were recorded. Thus it is clear that the malady is not confined to those exposed to the vicissitudes of the actual front. The number of officers affected has been very small, and in the earlier months of the outbreak a large series of cases occurred amongst the rank and file without any case in an officer falling under my notice; later, some cases occurred amongst officers. These were not limited to the more senior officers; some occurred in the younger men and some in the older. Up to the present time about one per cent of the cases have occurred amongst officers. The cases were of the same character as those seen in the men. In some there was distinct clinical evidence of old-standing renal disease, or of cardio-vascular degeneration. In others the cases were of the acute type described above, where the dropsy subsided rapidly and the albuminuria more slowly. Uræmic manifestations were sometimes present, and in one case uræmic epileptiform seizures that occurred quite suddenly, in a case of apparently no great severity, were followed by acute maniacal excitement. This, however, was also quite transitory, and the following day the patient was quite rational and had only a vague recollection of the seizure. In this case, as in others, the epileptiform seizure was preceded by a period of intense headache. There was no evidence of previous renal disease in this case, the only one, so far as I know, that presented that rather rare symptom of uræmia—mania.

One of the most striking features of the outbreak of nephritis was that it was confined to the British troops of the Expeditionary Force. It practically did not occur in the Indian troops, as I only know of three cases of nephritis having occurred amongst them. Three large Indian base hospitals, containing in all several thousand beds, were frequently visited by me, and I only saw, in a period extending over twelve months, one case, and this was extremely slight, some albuminuria but no dropsy being present. Two other cases were reported on the case-sheets. This absence of the disease amongst the Indian troops is very striking, as these troops suffered in common with the British

troops from other maladies commonly attributed to exposure. Thus, during the winter of 1914 and early spring of 1915, large numbers of cases of so-called frost-bite and trench foot occurred amongst the native Indian troops, and their hospitals contained large numbers of cases of bronchitis, dry pleurisy, and various forms of pneumonia. Bronchitis was especially prevalent and was often of a severe type, but yet nephritis and renal dropsy did not occur.

Some observations were also made on the question whether the incidence of the disease was materially affected by the length of time the men had served in France. In a series of 332 cases, data were available in 326 cases, and, as is seen, the results are not very definite; 195 cases occurred in men who had served six months or less in France, and 131 cases in men who had served from seven to twelve months. A small number of cases occurred in men who had only been out a month or less—in one case only one week. It is difficult to interpret these results, owing to the numerous possible fallacies. Thus the number of men who had only been in France a short time would in certain months be suddenly greatly increased owing to the arrival of fresh troops, and it is probable that the only deduction that is justifiable is that a considerable proportion of the cases occurred in men who had been serving from two to five months in France. Whether or no the malady had a greater incidence in those who had served ten and eleven months is uncertain, but in view of the smaller numbers of these men in the field it is possible.

Number of months served in France	1	2	3	4	5	6	7	8	9	10	11	12
Number of cases of nephritis	16	43	49	32	37	18	18	20	14	31	40	8

Total—Six months or less	195
Over six months	131
Grand Total	326

In one case the malady is said to have recurred, and this is probably correct, since the patient was invalided home after a slight attack and was discharged with the urine free from albumin. After a short furlough he was sent out to France again and there contracted another attack with œdema and albuminuria, but this attack also was not of great severity, and the dropsy speedily subsided. The causation of the disease is obscure. Modern views regard nephritis as usually produced by some toxic agency, and especially as the result of an infection, but the infection is often one that produces so little illness that it is overlooked. A series of

278 cases were analysed to try and ascertain whether any illness, slight or severe, had preceded the onset of the dropsy. In 10·4 per cent of these cases a history of a severe "cold," or of "diarrhœa," or of "influenza," or "sore throat," was elicited, and after a few days of illness the dropsy was noticed, but in the remaining eighty-nine per cent no such symptoms were noticed. On the other hand, in eighty-five cases, i.e., thirty per cent, the patients gave a history of and had distinct signs and symptoms of bronchitis, either at the actual onset or in the early stages of the nephritis when they came under observation in hospital. In some cases the bronchitis was quite severe. Bronchitis, so far as my experience goes, is the only frequent illness prior to the onset of the dropsy, and the bronchitis itself is of the acute type and rapidly followed or accompanied by the nephritis. Tonsillitis preceding the nephritis is very rare, and this was an unexpected result, since it is a well-known recognized cause of nephritis.

A plausible hypothesis might be advanced that the nephritis is causally related to the bronchitis were it not for the fact that bronchitis was common in the Indian troops and that in them no nephritis occurred. Notwithstanding this difficulty I am inclined to view the cases of acute nephritis described in this paper as due to some infection, the infecting agent causing in the first place in many cases some illness such as bronchitis, severe cold, diarrhœa, etc.

Some writers might see in this outbreak of nephritis evidence of the disease being directly due to cold and exposure. Others, seeing the gross contamination of the soil in the field of operations, might seek a cause in a microbic infection of the urinary tract. Such observations as have as yet been made on this point have not yielded concordant results, and the fact that the disease has occurred also at the bases is not in accord with this view.

Pending further observations on the causation of the malady, it may be said that clinically it is a distinct nephritis, characterized (1) by the rapid subsidence of well-marked renal dropsy; (2) by the frequent presence of bronchitis and dyspnœa; (3) by the severity and suddenness of onset of uraemic manifestations such as epileptiform seizures; (4) by the rarity of occurrence of inflammatory complications; and (5) by the extraordinarily low mortality, i.e., between 0·3 and 0·4 per cent as determined from the total number of cases that have occurred up to the present time. Although the uraemia convulsions are severe when they occur, yet their occurrence is exceptional.

PHYSICAL TRAINING, WITH ESPECIAL REFERENCE TO THE TRAINING OF CONVALESCENTS.

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Physical training has for many years been an integral part of the general training of troops. The soldier has, indeed, often been cited as an example of the good which must arise from a proper care and respect for the body. Lord Roberts was himself an exponent of this form of argument, holding, rightly enough, that the training received in the Army improved a man's physique, and, therefore, also his character.

The present Army councillors are in no way less keen than their celebrated colleague, and there is indeed a unanimous consensus of military opinion in favour of physical training. Equally, governments and civil authorities have often enough paraded healthy opinions, even carrying through apathetic Parliaments health-promoting bills innumerable. In spite of this, and in spite of an ever-increasing pressure of public opinion coming from the ranks of labour, very little has been actually accomplished. Physical training is still, in the minds of many, associated solely with gymnastic apparatus, or connected in some way with a certain class of quack advertisement. In the Army itself the high priests of physical training are the instructors of the gymnastic staff, and the set exercises, which in the general confusion are called Swedish, are, as it were, the prayer books of the true believers.

The *fons et origo mali* lies at the door of the medical profession. As there is no Minister of Public Health, so is there no Chair of Physical Training. The medical profession, in spite of certain sporadic warnings, still insists that its chief function is the cure of, and not the prevention of, disease. Medical gymnastics remain as a side-show, and not so long ago the chief professor to whom numerous doctors resorted was an ex-performer from the music-hall stage. Passive movement and massage stay suspect by the old school, or at best are relegated to those things which you may study if you please during the off hours of professional education.

This is the prologue. Is it any wonder the play itself should prove a thing of shreds and patches? It is well, then, if we admit

at once that the bulk of us know very little about physical training, and less about medical gymnastics, as only by a preliminary confession of scientific ignorance can we be saved from irresponsible theories and the dogma of a false empiricism.

It would be undesirable to disclose the percentage of casualties which eventually return to the firing line, but my experience of the German medical profession would lead me to suppose that in this, at any rate, our enemies are no better off than we are. We are naturally more athletic than they, and our love of games has saved to the Adjutant-General many thousands of fairly trained troops. It is with the hope that he may be saved many more that I am confining this article to the lines along which my present work lies—namely, the physical training of convalescent soldiers.

Here may I be permitted to issue a warning? The coming of peace will not abolish the convalescent soldier. To those of us who have been privileged to do what we can to make our heroes fit the remark should have a very special significance. There will be a huge number of convalescents and chronics on our hands at the close of the War. What are we going to do with them? Now there is one thing perfectly certain. If we propose to leave their cure to Nature a very large percentage of these men will never again be fit for full civil employ; the man-power of the nation will be thereby considerably diminished and the cost of pensions considerably increased.

Morally and economically it will be our duty to cure completely as many of them as possible. It will take perhaps a year or more, during which time the patient should remain under military discipline, and should receive proper treatment carried out on a scientific basis, under a system to be laid down. The tendency will be to let the men drift back into civil life in order to save expense. In the long run it will not save expense, but will prove a source of public discontent and be for years a heavy charge on the community. These men will be nearly useless in the labour market, and their own disabilities will, by undermining their resistance to temptation, drive large numbers into the ranks of intemperance and crime. The matter cannot be taken too seriously, as all experience points conclusively to the evils which spring, like fungus growths, from distempered states of physical health.

It is a lamentable fact to realize that nearly every one of us is miserably unfit, but it must be realized before we can devise a means of cure. The principal reason why we are thus unfit is because we do not like the methods of training suggested to us.

We have no time for them—the customary excuse; we really mean they bore us or actually annoy us. This psychology of the subject must always be borne in mind, since *pleasure* is one of the four essentials of physical culture. Exercises which are permanently distasteful to the patient may be written off as useless. I am writing now of set exercises, not naturally, of duties, which are often enough distasteful. Equally, exercises designed to achieve purely mechanical results need not be liked.

Four Essentials.

The four essentials of physical training are: *pleasure*, *exercise*, *balance and rest*. There are numberless other hardly less necessary fundamentals, as, for instance: cleanliness, abstinence, concentration; but for our purpose the four mentioned will form a sufficiently solid foundation for our detailed superstructures.

Pleasure.—It follows that we must have in any system a basis of pleasure. Convalescents must *like* their treatment. I have already remarked on the Briton's love of games, and have therefore interwoven into the system now being advocated for all big training centres one compulsory game. This is the game called at The King's Lancashire Military Convalescent Hospital, *Ballee*. The name given to it by Messrs. Slazenger, who are the makers, is *Gusto*. Gusto was invented especially for physical training, and now after much experiment and alteration remains, in my opinion, the best game existing for hardening off a man. The rules may be obtained from Messrs. Slazenger, who also supply the requisite apparatus. Gusto is inexpensive, it can be played indoors and out, and it does not require any elaborate preparation of grounds or playing fields. It is free from the dangers of football, and it promotes a more perfect development of muscle, a better "wind" and a quicker eye than other games. It is easy to learn, although rather difficult to play really well. It was first played at the Windsor Forest Institute of Physical Culture, and was being introduced to the notice of London clubs and gymnasia when the advent of War put a stop to its development. Gusto has now been made a compulsory game at some of the convalescent hospitals, and is daily proving its great value. It would be well if this game were made a part of the physicial training of all troops and also of all sailors. It could be quite easily played on most of our larger vessels of war. Gusto is, however, only one variety of exercise, and is only suitable for those who are past the first period of their convalescence.

Exercise.—When we come to deal with other less active movements, like free exercises, it should be remembered that all set movements have their accompanying mental effects. Upward movements have an exhilarating effect, downward movements a depressing effect. One movement is, therefore, not as good as another, and medical officers should be careful only to select suitable exercises.

Exercises are suitable or the reverse, according to what result is required. It is impossible within the limits of this article to give details, nor should it be necessary, provided the medical officer is the person responsible for the selection of the exercises. Exercise must be graduated to the state of health of the patient. If the reader will study the schedule of compulsory work he will see how this is done.

Within the limits of fatigue a muscle contracting a certain number of times rapidly produces the same effect as contracting an equal number of times slowly. It follows that to get quick results you must employ quick contractions. In other words, the pace of the exercises is important. In the camp this means that the quicker the exercises the more rapidly do you discharge your patients. Every individual has his limit of speed, beyond which rapid fatigue supervenes. Major Tait Mackenzie, Professor of Physical Training at the University of Pennsylvania, U.S.A., and now in medical command at Heaton Park, very rightly insists on this. As Major Tait Mackenzie is one of the very few who can afford to advise us on physical training, we should be doubly careful to remember this point.

There are other reasons why rapid movements are desirable. They produce perspiration and they improve "the wind." Rapid exercises should not be taken while in uniform, hospital clothing, or while wearing boots. Keep, therefore, a supply of running kit and of rubber shoes, and see that after profuse perspiration every man has a hot douche, followed by a cold shower and friction. If the water be not available the rubbing down can always be done. *Do not rub tired muscles in a direction away from the heart.* I have often noticed the "seconds" of boxers making this mistake.

It is a natural instinct of most convalescents to do nothing. Their treatment in a general hospital if anything determines them in the belief that rest is the only essential of physical training. On no account let this opinion become fixed. If it be advisable for them to do nothing—it very rarely is—let that nothing be done under orders and as part of their treatment. It is possible that some

cases only need "loafing" and fresh air, but never let the patient think so. It would, perhaps, be safer if medical officers also never thought so. Do not let special forms of treatment, like massage or electrical theurapeutics, interfere with exercise parade. This can be arranged by keeping cases under these treatments out of the advanced sections (see Schedule), or by having the treatments in the afternoons.

Neurasthenics are a great source of anxiety in convalescent hospitals. They require special exercises, the principle of which should be that they are short, quick, and followed by complete rest, lying down. Never keep neurasthenics standing about, and, as far as is practicable, squad them separately from others. It is as well to give all neurasthenics a preliminary four days of intestinal lavage, (modified Plombières treatment).

A man, like a horse, walks and runs on his feet; but although it be a commonplace to say a horse-trainer attends most carefully to his patients' hoofs, it is quite exceptional for a man-trainer to do so.

Military regulations lay down certain recommendations with regard to the care of feet, which in my experience are rarely observed.

Begin always with the idea that you cannot train a man at all unless his feet are sound. Watch, then, for dirt, for flattening, for corns, for sore places, for deformities of all sorts. In addition to the various remedies employed, attend particularly to the dryness of the socks, especially in cases of trench feet.

Flat-foot, because of its frequent occurrence, is one of the most expensive diseases in the British Army. It is especially liable to begin while convalescent from "frost-bite" and rheumatism. Recollect, too, that a man who has been bedridden for a long time while recovering from any disease or from wounds, is very prone to flat-foot. Make a note, therefore, of the time a patient has been actually kept in bed; if for more than a fortnight be exceedingly careful about the amount of exercise ordered, and see that he does not stand about. Special feet exercises should be given to all these cases.

There are many instances of feet which look flat, but which do not give rise to adverse symptoms. A simple test as to whether the arch has gone or not is to make the patient stand on his toes with the feet pointing forwards and inwards (test each foot separately).

A too prolonged route march when the men are insufficiently trained may easily result in several arches collapsing. Skipping

exercises in shoes strengthen the arch, and it is worth remembering that boys who have stopped growing cannot safely be exercised in stockinged or bare feet. Be careful also of permitting men to run barefooted on the sands after sea-bathing. There is no exercise for the muscles of the back better than digging. This also hardens the hands. The tug-of-war is another useful way to harden the hands and strengthen the back.

Rheumatism and myalgia are very common diseases in the Army. They are also very serious and require the most careful consideration by medical officers if a speedy cure is expected.

Make a rule of examining afresh the teeth of every rheumatic patient, and begin by remedying any defects, such as caries and pyorrhœa. It will be found on inquiry that the rheumatism usually began in the trenches—began, in fact, when the patient was having little or no exercise. Exercise all cases of rheumatism before trying any other form of treatment. We have had very remarkable results in this hospital by adopting that rule. Short sprints with jumping (and much groaning) should be tried, if possible getting up a sweat quickly. Unless care be taken it will be found that rheumatics tend to gravitate to the electro-massage department, forming there a kind of permanent sediment very difficult to remove. All of us have our pet ways of treating rheumatic affections; I would only ask that they should not be put into operation until exercise has been tried and has failed.

There are several classes of cases for which exercise is contra-indicated. I will instance: All recent wounds of the head that have penetrated the dura, or even reached the inner table; and valvular disease of the heart. The head cases frequently do well until they reach Section 3. Then they recommence with dizziness and headaches. It is doubtful whether much can be done—in the time—for them, but we are now trying ionization to the nape of the neck, both in these and in the "shell shock" and "blown up" cases. Our data is at present insufficient to form an opinion.

The treatment of valvular disease of the heart by exercises is too technical for the average convalescent hospital. The exercises and baths have to be extremely nicely graduated, and the time taken would be too long to make it worth while attempting. It is possible that something might be done in command depots. This is a class of case which may require treatment on a large scale after the War. On the other hand, "irritable heart" can be safely treated by exercise, provided the patient's tobacco can be strictly limited. But, here again, extremely nice gradation is necessary. A man

with an irritable heart very soon reaches his speed limit. Smoking should be forbidden absolutely for all patients during one hour before breakfast, dinner and tea.

The Army dietary is a difficulty when we have to deal with convalescents recovering from nephritis. Modified diets should not, save in very exceptional circumstances, be ordered in convalescent hospitals; they might be with propriety in command depots, and, indeed, in these institutions a dieted section should be arranged. I have laid down the rule here that if a patient still has albuminuria ten days after admission he is to be returned to his original hospital.

Balance.—The third essential of physical culture is balance. A subdivision of balance is style. Other things being equal, a well-balanced body means a well-balanced mind, and a good style while on parade or at exercise means a good soldier. The relationship between balance, style and character is intimate: as one improves so do the other two. This is of enormous importance in the training of convalescents.

There are very few men who are really panting to return to the inferno at the Front; there are very few men whose character does not tend to deteriorate under the stress of severe wounds or disease, accompanied by prolonged hospital life. All officers should bear this in mind, and no system of physical training which leaves it out of account should be considered.

The soul of a soldier is not something apart from his body, nor is it something which does not matter. The body is the instrument of the soul, and the soul, through the brain and mind of a man, is influenced by his body. You cannot make music on a cracked piano, you cannot make a soldierly character out of a cracked body. We are now approaching the holy places of physical training, and, like all mysteries, they are not understood by the mass.

Balance does not mean standing on one leg, although that is a valuable exercise. Balance is poise, it is the fine co-ordination between nervous substance and muscular substance which results in stability. To the practical instructor it should mean the absence of sloppiness and the vast importance of not being content with a badly done exercise. I can do no more here than insist on this aspect of physical culture being studied. It should be our pride to discharge from our care men who are physically better; it shouid be our greater pride to discharge them morally better also. Fortunately the one follows on the other, if our four essentials are constantly kept before us and demanded of our instructors.

This question is so closely bound up with rhythm, musical co-ordination, dancing (especially in the ballet)—all tremendous subjects—that I have left it unelaborated.

Rest.—Rest means mental and physical relaxation. It may mean lying down on a bed, it may mean playing a game of billiards. Whatever it means it should, during compulsory hours, be taken under orders. Compulsory hours are those between réveillé and dinner time, during which the troops should, as it were, be continuously on parade.

After the dinner-hour it is best to let a man do exactly as he pleases until bedtime, but we should endeavour to arrange for his pleasure various healthy amusements. We have found that six-a-side football matches, run on the League principle, are very well liked, and they have the advantage of being sufficiently exhausting. Only men in Sections 3 and 4 (see Schedule) should be allowed to play football without a medical officer's permit. Ballee matches can be arranged in the same way.

Below will be found some remarks on administration and organization, together with some of the charts used in the Record Office. At the end is the Schedule to which we work. It should be understood that where no description of what a man should be doing is given it means that during such times he is having special treatment, is resting, or is on fatigues. The organization of the staff is given in the form of genealogical trees, as it is hoped in this way to show most easily the administrative relationship of one official to another. It is, of course, remembered that the officer commanding is a doctor.

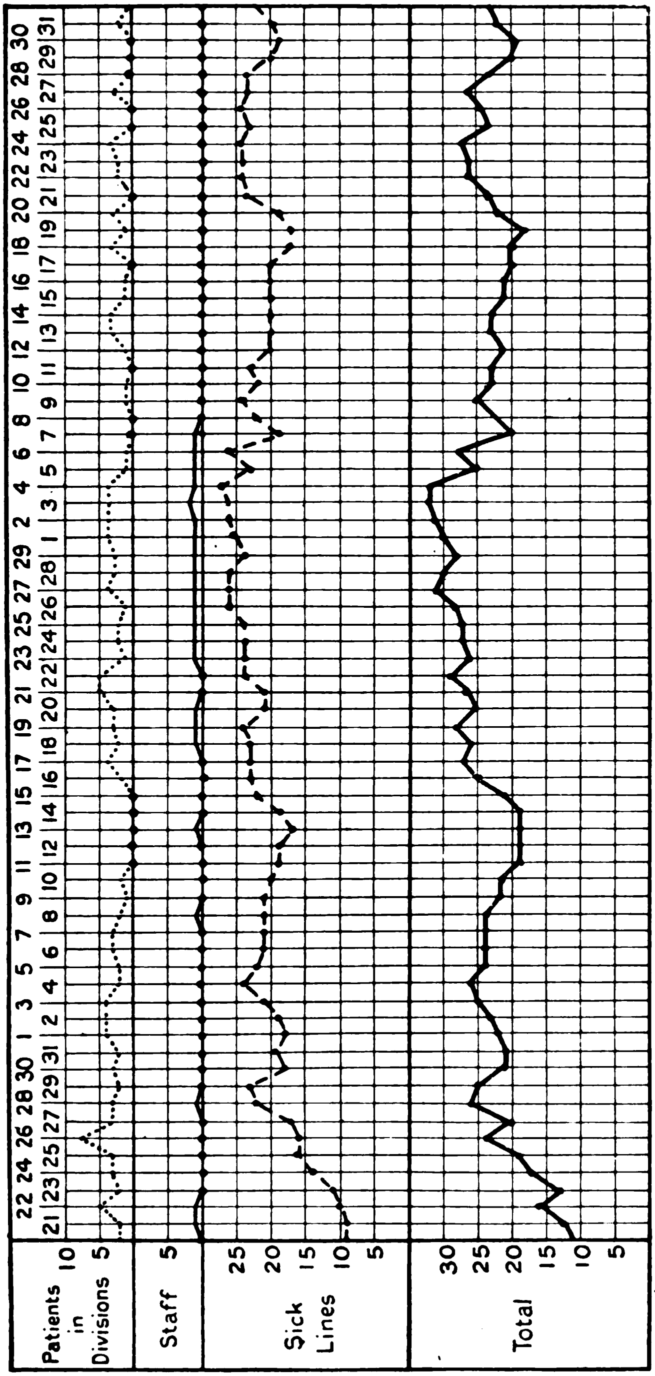
May I, in conclusion, offer an apology for the somewhat disjointed arrangement of the article? There are a great many points connected with physical training which I have not touched. I have endeavoured rather to emphasize what is unusual than to labour what is obvious.

The close relationship between mind and matter is knowledge of hoary age, but its adaptation to the training of both mind and body is very far from being fully appreciated. Compulsory exercises as practised in the Army are usually slow, with us they are usually rapid. We grade men by their health, not by their rank or regiment, and we insist that the medical officer should be the expert, and not the "professor" of gymnastics.

I have said nothing about rhythm, nothing about the effect of music on training, nothing about the hundred and one subjects which lie on the borderland between physical training and ordinary

Discipline (for checking Regimental Officers).

This shows the divisional discipline. Any undue rise or the absence of any cases from divisional orderly rooms is at once seen, and explanations, if necessary, demanded.

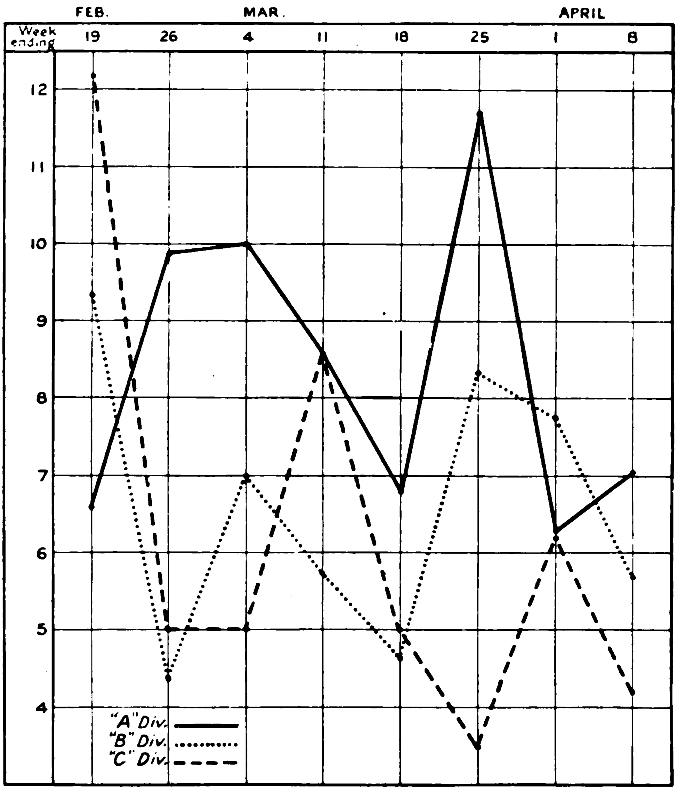


Sickness.

This shows the incidence of local illness—i.e., patients who are in bed in barracks, staff who are in bed in barracks, the number in sick lines, and the grand total. The trend of the general health can be seen at a glance.

medical and surgical treatment. All these things will bear much and careful thought, and all are matters of real urgency, both for civilian and soldier. In short, if I have succeeded in convincing my readers that I have left a good deal unsaid I shall have gained

Divisional. Weekly Percentage.



Discharges (for checking Medical Officers).

This shows the *percentage* of men discharged fit by each division per week. Any particular fall is noted and the medical officer concerned sent for to explain. Equally, medical officers can be congratulated on making a good return.

There are numerous other charts, but the examples given will sufficiently explain the system.

my chief point. After all, it is that which is yet to learn which leads us onwards.

I would wish to acknowledge my indebtedness to Miss E. Chynoweth, Secretary of the Record Office, for her preparation of the charts and for other work.

Notes on Gusto.

The rules of gusto as published do not contain any reference to a certain aspect of this game which should be noted by all physical training experts.

Gusto when played under the circumstances obtaining in temporary military camps serves its purpose admirably. For special class-work there is a development of it which should always be added. The decisions of the referee, who should whenever possible be the instructor, are given by whistle. Immediately the whistle sounds every player remains absolutely still in a balanced pose until the decision is given. The pose should not be premeditated, but should be such as can most easily be held following on the position of the body and limbs when the whistle went. The balance should be taken practically instantaneously and maintained without any swaying of the arms or shuffling of the feet.

Organization and Administration.

Divisions.—All men on admission are passed, according to accommodation available, into divisions. This is for *administrative* purposes only.

Sections.—They are immediately examined by the medical officers of divisions (500 men to a division), and posted to a Section —1, 2, 3, and 4. This is for *training* purposes only.

(1) *Section* 1.—The worst cases; namely, cases which are likely to require six or more weeks' training. The *average* length of time required to train a man is one month (31·5 days), which means that many require a considerably longer period.

(2) *Section* 2.—Cases which, although in better health, will yet take a month or six weeks to train.

(3) *Section* 3.—Men requiring only three or four weeks; and

(4) *Section* 4.—Men who are practically well, but not *hard*.

Armlets.—Sections are distinguished by armlets: (1) White; (2) pink; (3) light blue; (4) dark blue.

Convalescent Serjeants.—Convalescent serjeants, while not required to wear hospital clothing, must, however, wear the armlet of the Section to which they are posted.

Medical Examination.—Men are examined by divisional medical officers by Sections—Sections 1 and 2 on Mondays, Tuesdays, Thursdays and Fridays; Sections 3 and 4 only on Wednesdays and Saturdays.

At these examinations a man is moved up, or occasionally put back, from section to section as his condition indicates. These examinations are conducted under special instructions with the greatest care, and doubtful cases are brought up before a Standing Medical Board, which sits under the commanding officer every Tuesday. At this Board the commanding officer, in consultation with his medical officers, decides whether a man be in his proper section or whether there is no prospect of training him in a reasonable time. In this latter event he is sent back to the hospital which transferred him to the convalescent camp.

A man cannot be discharged to furlough until he has passed through Section 4. Three days before he is due for discharge he is paraded before the commanding officer, who then decides whether his discharge shall stand or whether he still requires further training.

A man who has passed through Section 4 is practically bound to be fit, so that in practice it is very rare for the commanding officer to disagree with a medical officer's opinion of a man's "hardness."

The more advanced a section the less general fatigues a patient has to do. Section 1 is made up of patients who are often too feeble for fatigues, therefore Section 2 gets most to do; Section 3 less, and S ction 4 practically none. Consequently, a man is biased towards progress to a higher Section. As the men progress in sections the work becomes faster and lasts longer. Running and jumping are much practised, both for improving the wind and for finding out weak spots.

Discipline.—The utmost possible freedom is allowed to all ranks, and as the actual training is over by the dinner-hour they have the afternoons and evenings to themselves—but only provided the discipline is good. If a man be brought up before the officer in command he is reverted to hospital rules, which means that he cannot leave camp, and in the case of a serjeant has to wear hospital clothing. There has been practically no trouble with discipline.

It will be noticed that the amount of compulsory "work" varies from three-quarters of an hour to three hours. Section 4 has three hours' strenuous exercise under supervision every morning except Sunday. This, with the extra amount put in voluntarily in the afternoons, is found quite sufficient.

Sections 2, 3, and 4 are divided further into sub-sections, according to the health of the men. *Sub-sections* are commanded

by patient N.C.O.'s, *Sections* by staff N.C.O.'s. A man passing from sub-section to sub-section does not come before a medical officer.

Patients requiring massage or electrical treatment are not advanced beyond Section 2 until the treatment be no longer necessary. A special medical officer is appointed to the electro-massage department. It is his duty to report to divisional medical officers when he considers a patient has had sufficient massage, etc.

Record Office.—A very perfect system of checking the work of regimental and medical officers is in operation, culminating in the Record Office. Here are kept all the particulars of "results," which are daily entered on large and simple charts. For example, a medical officer can tell at a glance how the "results," that is, the discharge rate, of his division compares with the "results" of another division. Similarly, a regimental officer can tell whether the discipline of his division is relatively good or bad. All officers have to attend the Record Office to study the charts twice a week. Specimen charts are given as a guide.

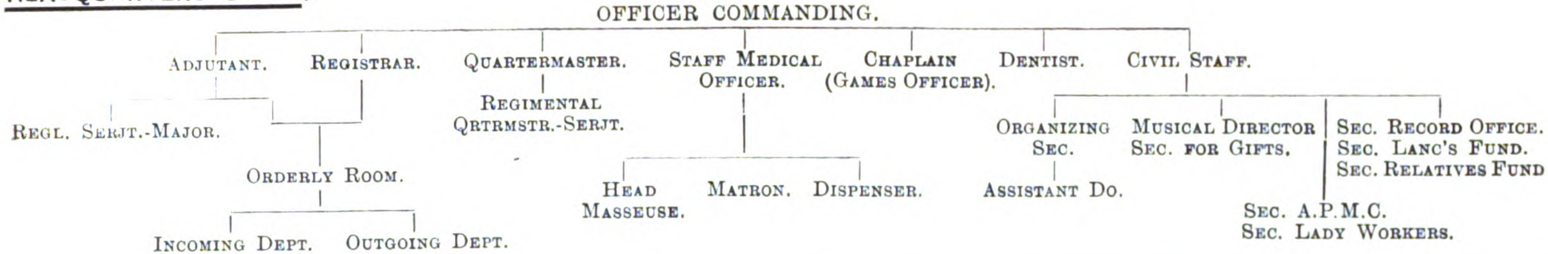
To Sum Up.

Our efforts are directed to producing a hard and fit man in the shortest possible space of time. This is best done by gradually, but rapidly, *increasing the speed of his work,* omitting apparatus work altogether and reducing the amount of time spent on route marching. Provided the feet are properly hardened, to which we attend, a man trained on this system will always outlast the ordinary marcher. There are, naturally, many points not covered in the above report, particularly those arising through individual peculiarities.

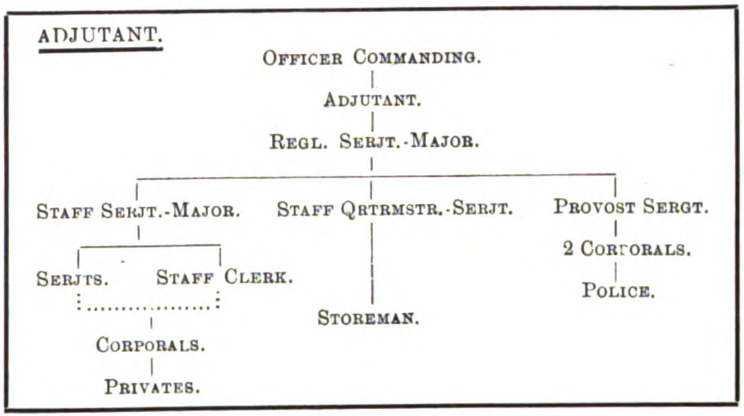
Some patients are too old for very fast work, although *for their age* they may become fit enough. Special sub-sections are devoted to these. Others have maladies which necessitate particular treatment. Still other cases are treated in our sick lines (this is a separate hospital altogether, although officered by our doctors).

Trench feet cases attend daily at the Central Dressing Station, where their feet are thoroughly dried, and then rubbed with equal parts of lin. belladonnæ and tinct. iodi. Dry socks are then put on. Beyond this and the insistence on the repeated drying of the socks it is best to leave trench feet alone.

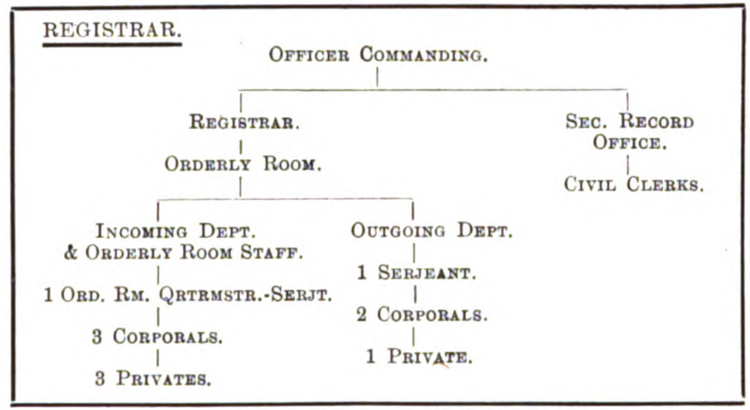
HEADQUARTERS STAFF.



ADJUTANT.



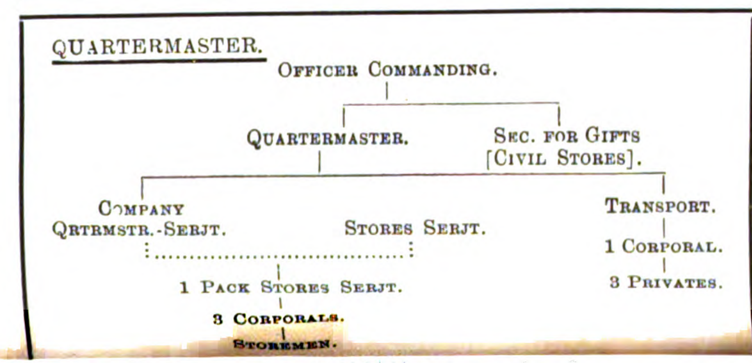
REGISTRAR.



K.

L.

QUARTERMASTER.

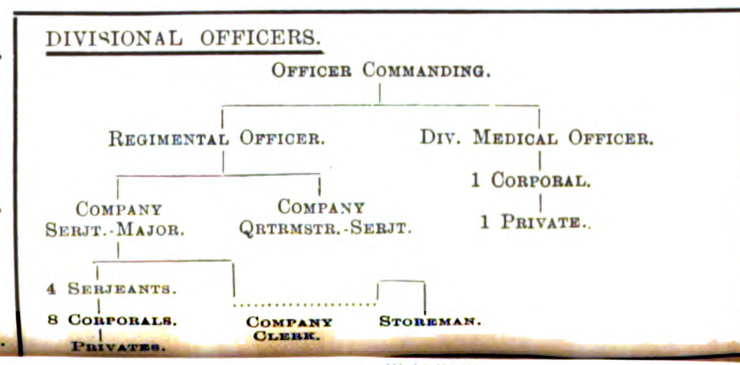


M.

C.

H.

DIVISIONAL OFFICERS.



For the Purposes of the Schedule ——

Marching	means	route marching—slow to fast.
Physical Training ..	,,	Swedish drill, boxing, skipping, free exercises, etc.
Running	,,	sprinting, distance running (road or cross country).
Scouts' Pace	,,	trotting and walking alternately.
Jumping	,,	generally long, sometimes high, jumping.
Rest	,,	actual rest—namely, a man has to keep quiet or lie down on his bed if so ordered.

N.B.—All exercise which makes a man really sweat has to be taken in "civil kit."

Section 1.

6.45 a.m.	Réveillé.
8.0 ,, ...	Breakfast.
8.30 ,, ...	Make bed. Clean barrack room.
9.0 ,, ...	—
9.30 ,, ...	Medical inspection.
10.0 ,, ...	—
10.30 ,, ...	—
11.0 ,, ...	Marching, 11.0 a.m to 11.45 a.m.
11.30 ,, ...	—
1.0 p.m.	Dinner.
5.0 ,, ...	Tea.
	Total work, ¾ hour.

Section 2.

	No. 1 Sub-section (fast squad)	No. 2 Sub-section (slow squad)	No. M. 3 Sub-section (residue of Nos. 1 and 2 Sub-sections, with bad physical defects)
6.45 a.m.	Réveillé	Réveillé	Réveillé.
8.0 ,,	Breakfast	Breakfast	Breakfast.
8.30 ,,	Make bed. Clean barrack room	Make bed. Clean barrack room	Make bed. Clean barrack room.
9.0 ,,	.. — ..	— ..	. —
9.30 ,,	.. Medical inspection (except on Wednesdays and Saturdays; then time occupied by skipping.)		
10.0 ,,	.. — ..	— ..	—
10.30 ,,	.. — ..	— ..	—
11.0 ,,	Marching, 1 hour ..	Marching, ¾ hour ..	Marching, ¾ hour *only*.
11.30 ,,	Physical training, half hour (till 12.30 p.m.)	Physical training, half hour (till 12.15 p.m.)	—
1.0 p.m.	Dinner	Dinner	Dinner.
5.0 ,,	Tea	Tea	Tea.
	Total work, 1½ hour ..	Total work, 1¼ hour ..	Total work, ¾ hour.

Note.—All massage and treatment, as far as possible, to be finished in time for parade at 11 a.m. No heart cases are posted further than Section 2. Cases requiring massage or major dressings are not posted beyond Section 2.

SECTION 3.

	No. 1 Sub-section (fast squad)	No. 2 Sub-section (medium)	No. M. 3 Sub-section (modified training for men over training age, and with physical defects)
6.45 a.m.	Réveillé	Réveillé	Réveillé.
8.0 ,,	Breakfast	Breakfast	Breakfast.
8.30 ,,	Make bed. Clean barrack room	Make bed. Clean barrack room	Make bed. Clean barrack room.
9.0 ,,	Scouts' pace, and physical training	Scouts' pace, and physical training	—
9.30 ,,	Road running ..	Ball	Physical training, marching, and ball.
10.0 ,,	Rest	Rest	—
10.30 ,,	Route marching (till 11.45 a.m.)	— ..	—
10.45 ,,	.. — ..	Route marching (till 11.45 a.m.)	—
11.0 ,,	.. — ..	— ..	(Duration of work, 2 hours.)
11.30 ,,	.. — ..	— ..	—
1.0 p.m.	Dinner	Dinner	Dinner.
5.0 ,,	Tea	Tea	Tea.
	Total work, 2¼ hours ..	Total work, 2 hours ..	Total work, 2 hours.

Medical Inspection.—9.30 a.m. Wednesdays and Saturdays. (*Wednesdays:* Marching, 11.0 a.m. to 12.30 p.m. *Saturdays:* Marching, 11.30 a.m. to 12.45 p.m.)

SECTION 4.

	No. 1 Sub-section (fast squad)	No. 2 Sub-section (medium squad)	No. 3 Sub-section (slow squad)	No. M. 4 Sub-section (modified training for men over training age, and with physical defects)
6.45 a.m.	Réveillé ..	Réveillé ..	Réveillé ..	Réveillé.
8.0 ,,	Breakfast ..	Breakfast ..	Breakfast ..	Breakfast.
8.30 ,,	Physical drill ..	Physical training	Physical training	Physical training.
9.0 ,,	Digging ..	Digging ..	Digging ..	Walk.
9.30 ,,	Rest	Rest	Rest	Rest.
10.0 ,,	Games, sprinting and gusto	Games, sprinting and gusto, *modified*	Slow running ..	Physical training.
10.30 ,,	Games, sprinting and gusto	Games, sprinting and gusto, *modified*	Ball	Rest.
11.0 ,,	Rest	Rest	Rest	Marching (till 12.30 p.m.).
11.30 ,,	Marching (till 12.30 p.m.)	Marching (till 12.30 p.m.)	Marching (till 12.30 p.m.)	Marching (till 12.30 p.m.).
1.0 p.m.	Dinner ..	Dinner ..	Dinner ..	Dinner.
5.0 ,,	Tea	Tea	Tea	Tea.
	Total work 3 hours	Total work, 3 hours	Total work, 3 hours	Total work, 3 hours

Medical Inspection.—9.30 a.m. Wednesdays and Saturdays. (*Wednesdays:* Omit 10 a.m. to 10.30 a.m. parade. *Saturdays:* Omit 10 a.m. to 10.30 a.m. parade.)

EXPERIENCES OF TWELVE MONTHS' X-RAY WORK IN FRANCE.

By Captain T. S. ALLEN.
Royal Army Medical Corps.

THE apparatus used throughout has been the 1913 Field Service pattern, and this, with the addition of a movable tube stand and a stereoscope, has proved adequate for all purposes. Current is obtained from twenty two-volt accumulator cells which are charged from the small engine and dynamo set provided.

Two mammoth tubes have been used alternately, and excessive exposures are not necessary—a hand requires about thirty seconds—and, with the exception of the pelvic region, no exposure of over two and a half minutes is made. A valve-tube has proved, with this apparatus, of even greater value than usual.

Screen Examination.

It has been made a rigid practice to screen as few cases as possible, and this course has been adopted for several reasons:—

(*a*) It is difficult completely to protect the operator with the apparatus provided, which is of necessity somewhat light; and in any case he runs considerable risk if constantly screening cases.

(*b*) Periosteal swellings and slight lesions of bone, such as are frequently met with, would probably be missed under the screen.

(*c*) It is advisable to have a permanent record of cases in the form of plates.

(*d*) The X-ray room is situated in a hut, and would require considerable alteration to render it light-proof; screening is therefore carried out at night.

Wounds or diseases of the chest or abdomen are the only conditions for which screen examination has regularly been employed.

All wounds of the thorax in which there was any suspicion of penetration of the pleura have been screened as a routine measure; the missile in all these cases has been either a bullet or a shell fragment. No case has been seen in which a shrapnel ball has entered the thoracic cavity.

Hæmothorax has been readily shown, and this has been of considerable importance, as pointed out by Colonel Sir John Rose Bradford, owing to the anomalous physical signs of this condition—

e.g., one case in which there was no marked dullness on percussion, the blood being still in a fluid state, filling half the right chest, and the cardiac beat imparted a rhythmic ripple to the surface of the fluid.

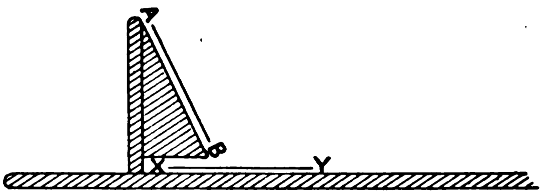
A few cases of medical interest have also been screened. Two cases of undoubted aortic aneurysm were seen, one or two cases of slight persistent pyrexia with vague physical signs were shown to have chronic phthisis, and two cases of hepatic abscess were shown, the diagnosis being subsequently confirmed by operation.

Bismuth meals were given to a few patients complaining of obscure abdominal symptoms, and the passage of the meal was normal in all cases.

Radiography.

Plates have been exposed in all types of cases other than those of the thorax and abdomen mentioned, and this practice has proved uniformly satisfactory. It has been extremely rare to find that foreign bodies have been missed by this method, though no preliminary screening has been done, and a far more accurate estimate of the condition has been obtained by the taking of plates, frequently in two planes, than would have resulted from use of the screen.

The tube is always carried above the table, as considerable experience has shown that this is simpler and more comfortable for the patient. Exposures of the head are made with the patient in the prone position with a minimum of discomfort and movement, even the most severely injured bearing this position very well. For radiography of the foot and ankle a simple wooden rest has been made.



In taking a skiagram of the tarsus the plate is rested on the footpiece in the position A—B, while for the ankle region the plate lies in the position X-Y; in either case, the foot is lightly bandaged to the rest and the tube is tilted, so that the rays will fall directly upon the required parts.

Radiography of other parts presents no difficulty unless the

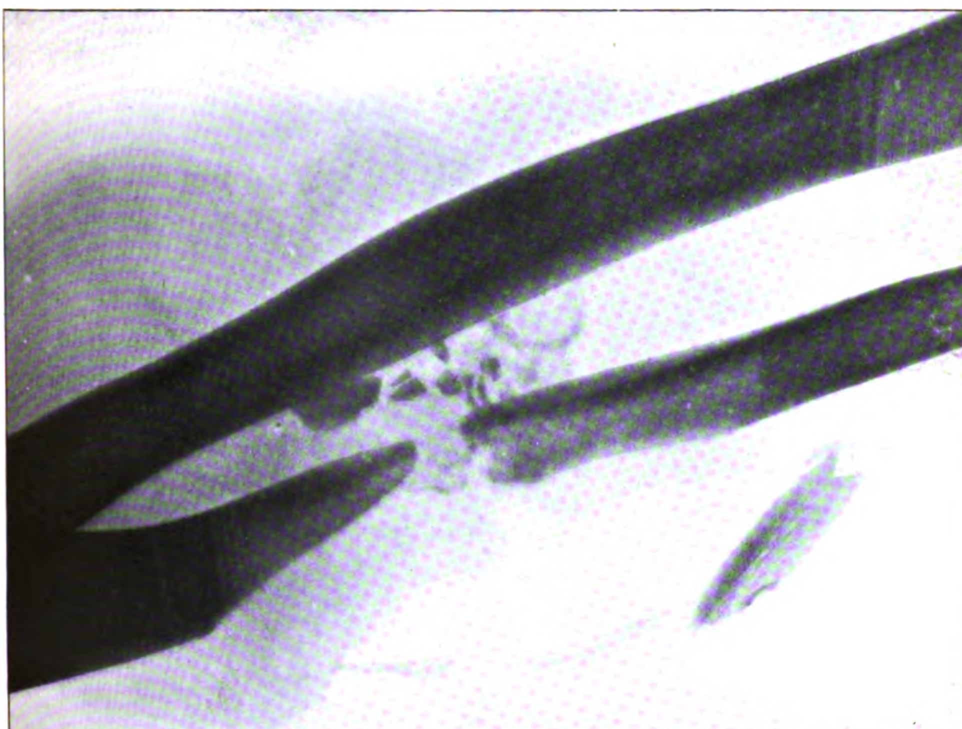


Fig. 1.

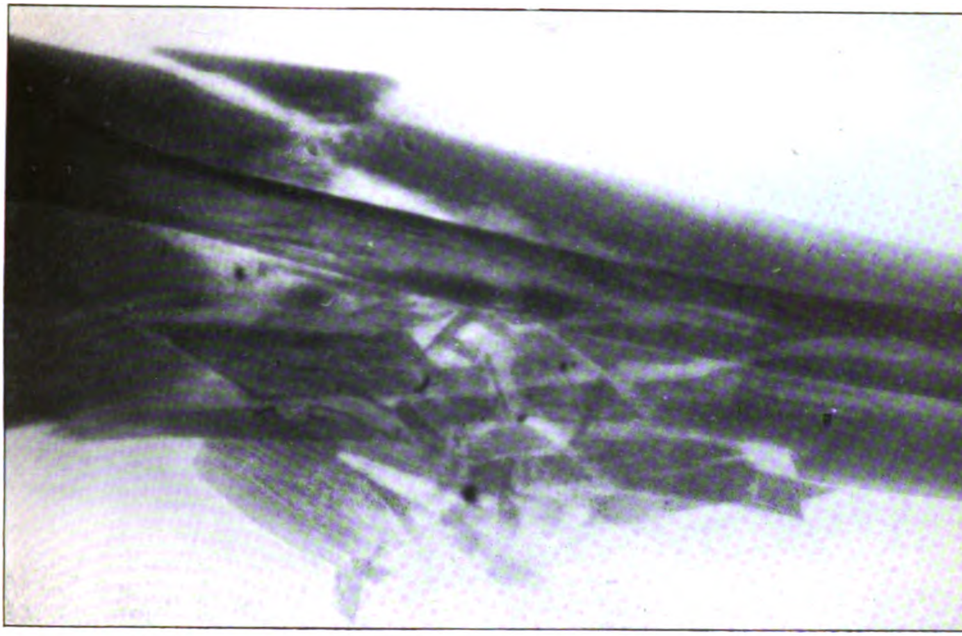


Fig. 2.

To illustrate "Experiences of twelve months' X-ray Work in France," by Captain T. S. Allen, R.A.M.C.

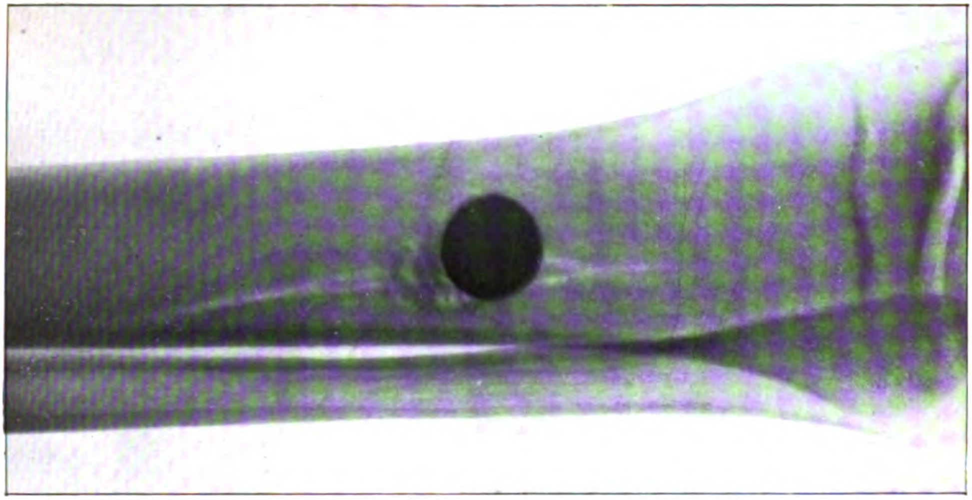


Fig. 4.

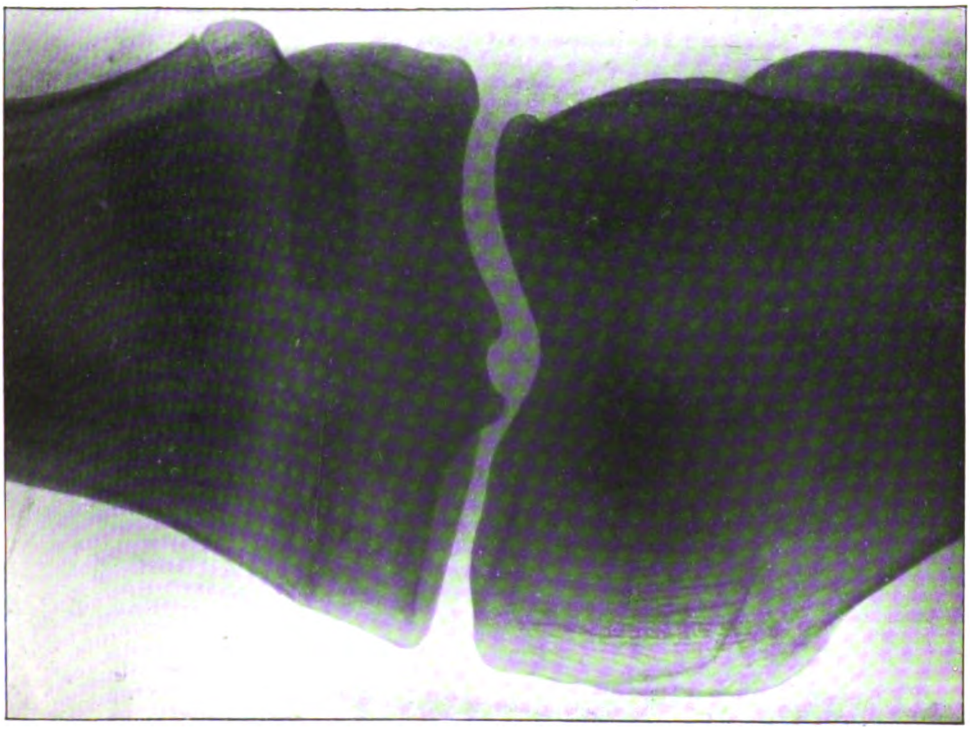


Fig. 3.

To illustrate "Experiences of twelve months' X-ray Work in France," by Captain T. S. Allen, R.A.M.C.

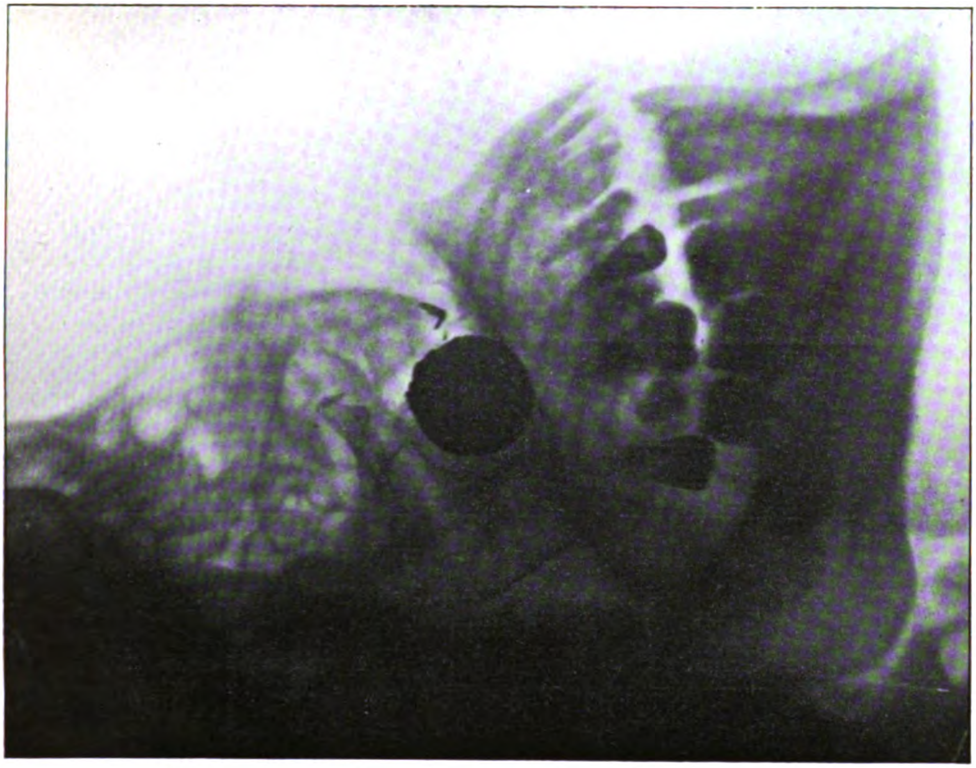


Fig 6.

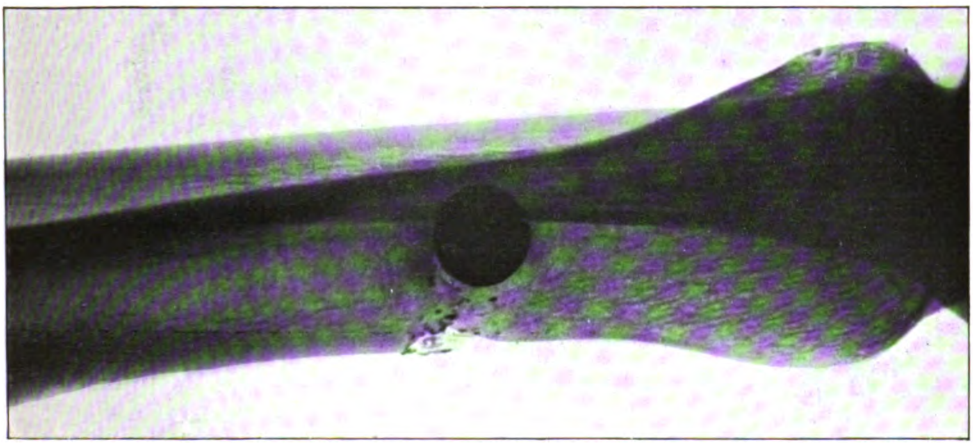


Fig. 5.

To illustrate "Experiences of twelve months' X-ray Work in France," by Captain T. S. Allen, R.A.M.C.

patient is very severely wounded and suffers great pain from movement. If this be the case the stretcher on which the patient is carried is lifted directly on to the table; the plateholder of the Mackenzie-Davidson apparatus is then slipped under the injured part and stereoscopic plates exposed, allowing the patient to lie in whatever position he finds most comfortable.

A certain amount of ordinary surgical radiography, mostly from neighbouring base camps, has been done, but nothing of unusual interest has been noted about this work.

Many cases come down from the front marked "injury to back," which are apt to be treated somewhat lightly, as they often walk into hospital, yet radiographic examination occasionally reveals a fractured vertebra, usually of the lumbar region. With the exception of these cases, almost the entire work of the department deals with the results of wounds caused by hostile missiles, and a very large proportion of these occur about the head and limbs.

It is difficult to draw other than the broadest conclusions from the evidence of these skiagrams, as the conditions under which the injuries are caused vary so immensely in regard to projectile, range, force of explosion, and position of the patient at the time of injury.

A consecutive series of five hundred cases was analysed and divided into two sections—(*a*) those in which metal was present in some form, but there was no injury to bone; (*b*) those in which there was some bone lesion.

(*a*) In these cases the nature of metal was:—

Fragments of shell (type not identified)	89·0 per cent
Bullet (rifle or machine gun)	6·1 ,,
Shrapnel ball	4·9 ,,

The high proportion of wounds caused by various types of shell is well brought out by this series, but otherwise these skiagrams present little interest.

(*b*) These cases, in which there was a definite lesion of bone gave the following result on analysis:—

No metal present	48·6 per cent
Fragments of shell	37·7 ,,
Shrapnel ball	7·2 ,,
Bullet..	6·5 ,,

It will be noticed that in nearly half of these cases, which were mostly fractures of long bones, the missile has not remained in the body. In some the metal has been removed or has dropped away before admission to hospital, but in the greater number there

were obvious wounds of entry and exit. These have been caused by missiles of high velocity, and it has been found from the statements of the men and the nature of the entry wounds, that the cases with the most extensive damage to bone have usually been wounded by rifle or machine gun bullets.

Fig. 1 is a common example of wound of a long bone by rifle bullet at short range. There was a small entry wound, and the exit wound resulting from the explosive action of the bone fragments was so great that the patient insisted that he had been hit by a "Dumdum" bullet.

Fig. 2 shows a similar case in which there was a minute entry wound on the postero-external aspect of the leg, with a very large exit wound on the inner side.

While fractures of the above type are frequently caused by rifle bullets, and though bullets are commonly observed about the trunk, it is rare to find whole bullets in or near fractured long bones; when they do occur they have usually entered at low velocity and are embedded point foremost in the bone.

Fig. 3 shows a rifle bullet buried in the cancellous tissue of the head of the tibia, with no gross injury to the bone.

Lesions of bone in which shrapnel balls are present form an interesting and distinct group. When shrapnel balls strike bone they tend to lodge in or near the bone, and do not, as a rule, cause very extensive injury. This is due partly to their spherical shape, which they usually retain, and partly to their comparatively low velocity.

Figs. 4 and 5 are from a typical instance of fracture by shrapnel ball, which has wedged itself into the shaft of the tibia and has caused only a local splitting of bone.

Fig. 6. The ball has dropped through the anterior wall of the antrum and is lying on the floor.

Fig. 7. In this case there is more bony damage than is usual, but the ball has remained in the bone.

Shell fragments causing injury to bone vary so greatly in size, shape, velocity and number that almost any type of fracture may be met.

Fig. 8 shows a bomb wound of the hand. The palmar aspect is filled with tiny fragments, and there are numerous small lesions of bone.

Fig. 9. A large piece of shell struck the forearm, tearing the posterior surface open from elbow to wrist, and, passing on, left behind a trail of little metal fragments and the ulna comminuted to the utmost.

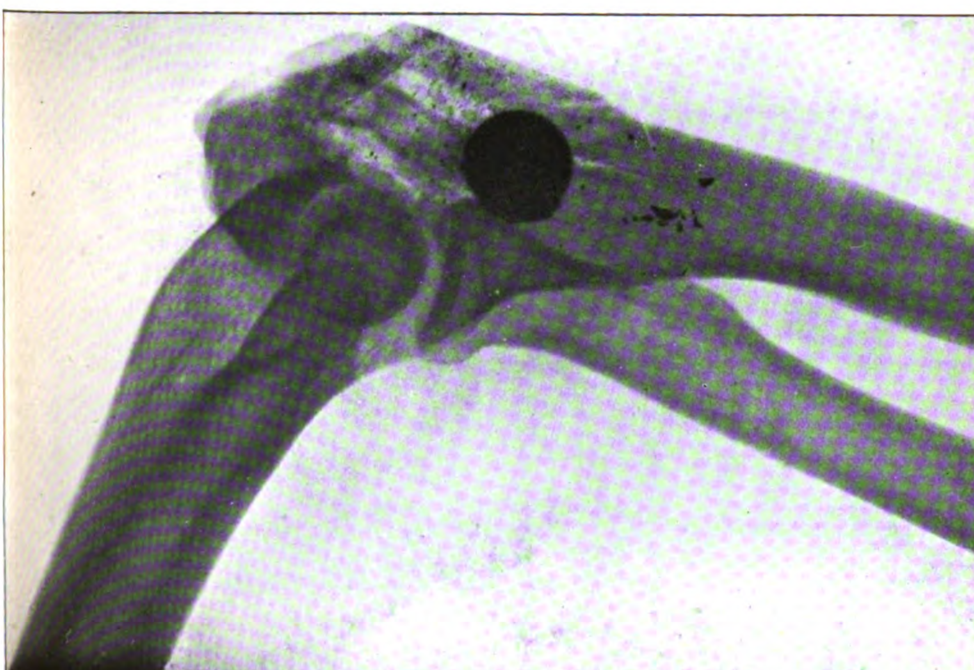


Fig. 7.

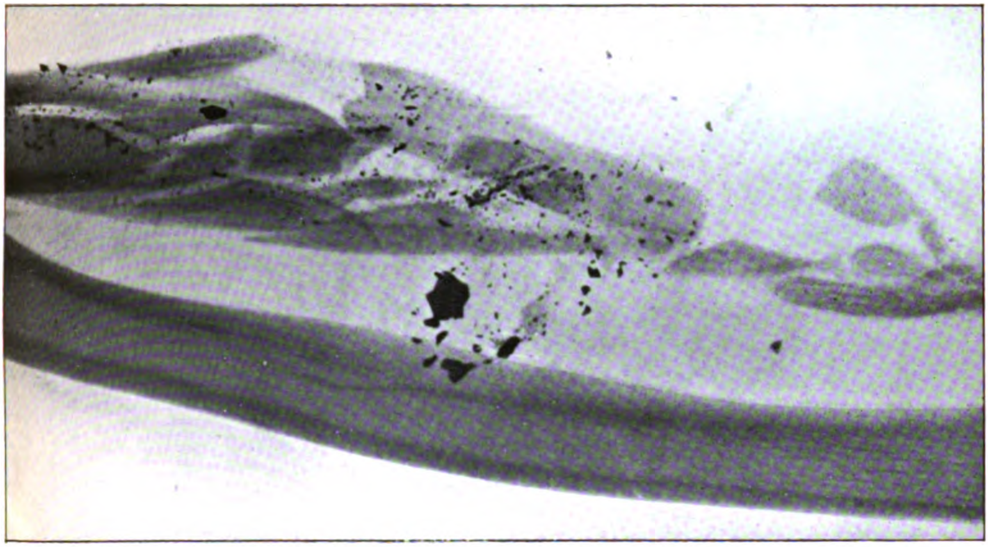


Fig. 9.

To illustrate "Experiences of twelve months' X-ray Work in France," by Captain T. S. Allen, R.A.M.C.

Fig. 8.

To illustrate "Experiences of twelve months' X-ray Work in France," by Captain T. S. Allen, R.A.M.C.

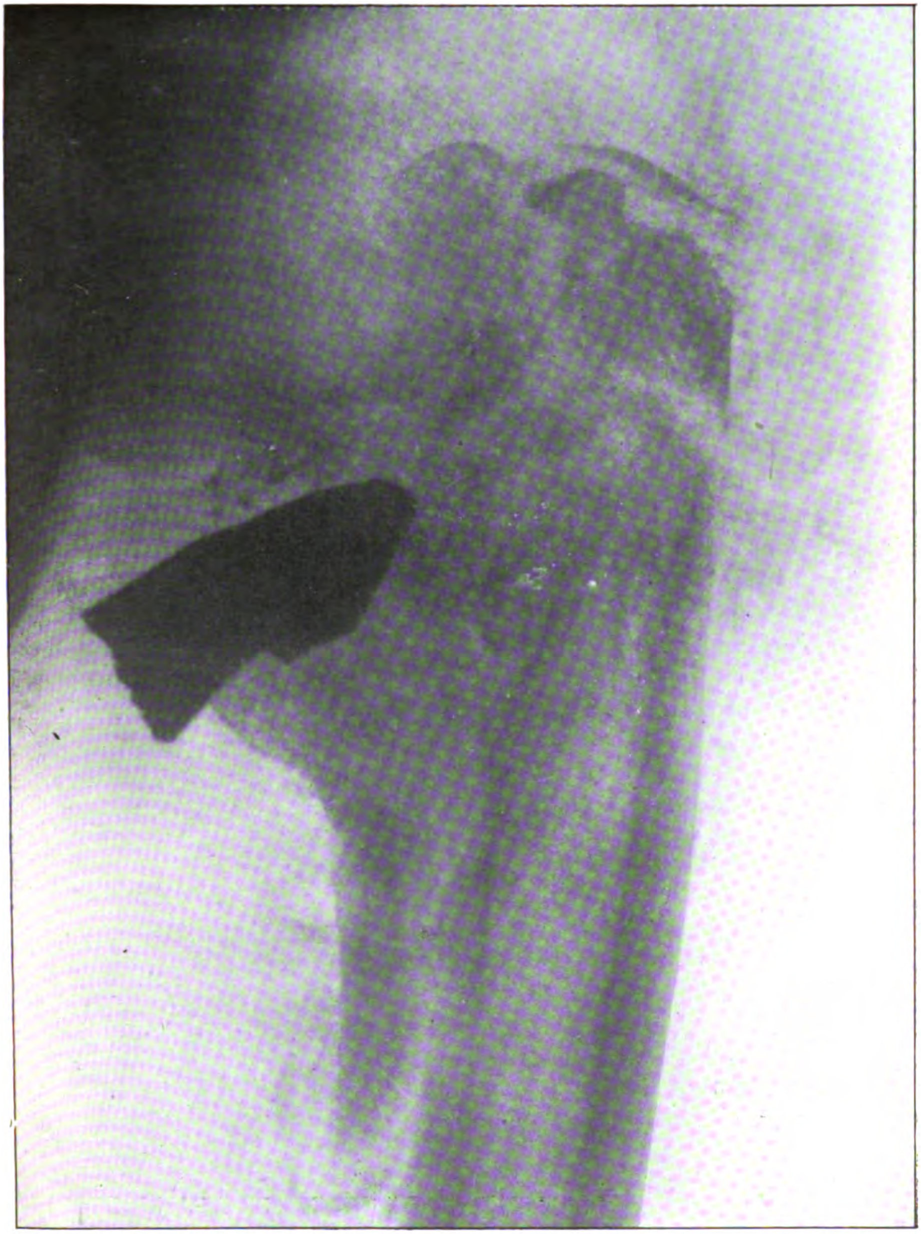


Fig. 10.

To illustrate "Experiences of twelve months' X-ray Work in France," by Captain T. S. Allen, R.A.M.C.

Fig. 10. A single mass of metal from the base of a shell has entered the outer side of the thigh, torn through the great trochanter and remained wedged in the neck of the femur.

Localization and Stereoscopy.

The experience has been the common one—that very accurate localization of foreign bodies or bone fragments is rarely necessary in the type of surgical work performed at a base hospital with the British Expeditionary Force; operations are mostly those of urgency, and are not usually undertaken simply for the removal of metal, without the presence of sepsis, great pain or other factor. When accurate localization has been required, as in wounds of the head, the Mackenzie-Davidson instrument has always been used, being simple and precise in working.

In the majority of cases ample information has been obtained by other methods—radiograms taken in two planes or with a metal probe passed along an obvious sinus.

Stereoscopic radiography also has proved of the utmost value in wounds of the extremities and in the identification of foreign bodies and fractures about the shoulder and root of the neck, many unsuspected fractures of the scapula and upper ribs being revealed by this method.

The work of the radiographer is always simplified when his colleagues show discrimination in the cases they send to him. In this respect and in the assistance given to me by Serjeant G. Taylor, R.A.M.C., I have been singularly fortunate.

ON THE DIFFERENTIAL BACTERICIDAL VALUES OF MALACHITE AND BRILLIANT GREEN FOR THE TYPHOID-COLI GROUP.

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Royal Army Medical Corps.
AND
Lieutenant I. P. S. DUNN, M.B.
Royal Army Medical Corps.

Criticism of Existing Methods for the Isolation of Bacillus Typhosus.

The problem of the isolation of members of the typhoid-coli group has been the subject of much study and, in view of the prevalence of intestinal infection, has recently acquired a special importance. For it has been recognized that the rôle of the bacteriologist embraces not only the question of diagnosis but, with a view to the elimination of "carriers," is even more intimately concerned with the determination of the period during which the convalescent is capable of functioning as a focus from which infection may be distributed. Sero-agglutination methods have become complicated by the almost universal inoculation of our troops; and, moreover, though certain presumptive evidence may be deduced from a positive reaction, no information regarding the duration of the infective period can be derived from a negative one. For purposes of diagnosis, therefore, reliance must to a large extent be placed upon the direct isolation of the infecting organism from the blood and stools, and freedom from infection can only be determined by successive endeavours to cultivate the infecting organism from the excreta.

Difficulties inherent in all Methods: their Nature.

The difficulties inherent in all methods which have been devised for the attainment of this object may be summed up in the expression of the natural antagonism which appears to exist between the *Bacillus typhosus* and the *B. coli*, and coliform organisms, and which in the latter group of organisms tends to the suppression of the former. Indeed Rémy and others have noticed that when the *B. typhosus* and *B. coli* are grown together, not only is the viability of the *B. typhosus* diminished but the biological characters of either may be profoundly modified. Thus the property of agglutinating

with a specific serum may be, consequent upon symbolic association, in abeyance, so depriving us of our most certain and final test for the identification of bacteriological species. The methods themselves have been, for the most part, based upon the employment of media which either, by means of an indicator, facilitated the naked-eye detection of colonies of the *B. typhosus*, or which, by the elimination of organisms other than those of the typhoid-coli group, especially favoured the development of the latter. Many were devised with the object of overcoming natural antagonisms by the incorporation of various substances, viz.: brilliant, china and malachite greens, caffeine, bile salts, etc., which, by diminishing the viability of the *B. coli* and coliform organisms, facilitated the isolation of the *B. typhosus*.

UNRELIABILITY OF SOLID MEDIA FOR EFFECTING THE ISOLATION.

Their use on solid media was, however, attended with certain definite disadvantages; when the number of infecting organisms was large no difficulty was experienced, but, in the contrary event, when small the examination of a proportionately greater quantity of infected material was required and, in order to obtain discrete colonies, the manipulation of a large surface of medium, involving in many cases the cumbersome process of multiplied platings, was necessitated. Furthermore, as has been recently pointed out by Messrs. Dreyer, Gibson and Walker, not only do many of the media in common use not enchance (employing the term in its widest application to imply either the direct stimulation to the growth of the organism whose isolation is desired or the inhibition of antagonistic organisms whose activities would otherwise impede its development) the growth of the *B. typhosus*, but the reverse is actually the case. For these observers found, most markedly in the case of Conradi's and MacConkey's media, less so in that of Endo's; that in comparison with the number of colonies of *B. typhosus* and *B. coli* which developed on an agar plate, while the *B. coli* suffered little diminution the viability of the *B. typhosus* was most markedly inhibited, and that when the latter was in less than a certain proportion to the former it might entirely fail to reproduce itself on plate cultures of these media.

Our own results on the comparison of the growth of *B. typhosus* and *B. coli* when plated on different media agree in the greater development of *B. typhosus* on agar than on MacConkey and Endo, but the amount of growth on the two latter shows little difference. The readiness with which single colonies of *B. typhosus* can be recognized on MacConkey gives this medium a great advantage.

"Enhancing" values of certain Aniline Dyes in Fluid Media.

That certain aniline dyes, besides exerting a powerful bactericidal influence upon Gram-positive organisms, possess the property of inhibiting the *B. coli* to a greater extent than the *B. typhosus* has long been recognized. Thus as early as 1902, Conradi remarked on the enhancing value for the *B. typhosus* of both brilliant and malachite greens, and later introduced an agar medium containing picric acid and brilliant green which, in a modified form by Fawcus, has been successfully employed at the Royal Army Medical College in the investigation of typhoid carriers. Loeffler, however, first pointed out the fact that by the use of fluid media containing malachite green the viability of the *B. coli* was impaired and the *B. typhosus* could be most readily isolated. His work has been confirmed and extended by many observers, but more particularly by Messrs. Browning, Gilmour and Mackie who, in an article published in 1913, established the basis of the superiority as an enhancing agent of brilliant to malachite green. Employing varying concentrations of brilliant green these observers succeeded in isolating the *B. typhosus* (and *B. paratyphosus*) in thirteen cases in seven of which it was found impossible to obtain either by means of direct plating on MacConkey's medium.

Nature and Scope of the Present Inquiry.

In view of the number of cases which have been admitted to this hospital presenting symptoms of intestinal disorder and of the necessity arising thereby for the adoption of a method, at once the most simple and the most effective possible, for the isolation of the infecting organisms, we have recently been engaged upon an investigation of the different bactericidal values for the typhoid-coli group of malachite and brilliant greens. Following the procedure of the authors of the technique we have endeavoured to determine the relative viability of the *B. coli*, *B. typhosus*, *B. paratyphosus* A and B and various strains of the dysentery bacillus in relation to both dyes. We have, however, for the most part employed artificial standardized mixtures in our experiments and consequently in our results tabulated below, do not attempt to reproduce the sequence of events following upon the inoculation of a fluid medium containing brilliant (or malachite) green with a specimen of infected fæces, in which, in view of the organic material introduced and the variations of the organisms themselves disturbing factors might be

anticipated. We have merely concerned ourselves with an endeavour to determine under standard conditions the precise value of brilliant and malachite greens in effecting the isolation of various organisms in mixture with the *B. coli* in the anticipation that the information derived thereby might be of guidance in the larger problem of the isolation of the organisms from the fæces.

Preparation of Enhancing Medium.

Brilliant green (derivative of tetraethyl-diamido-triphenyl-methane) is obtainable in green crystalline plates readily soluble in water and alcohol, more sparingly in ether and yielding a whitish cloud in the presence of traces of ammonia. A stock solution of 1 in 100 is prepared with distilled water. This solution is sterile and will maintain unimpaired for weeks or months its antiseptic properties. Before use a 1 in 10,000 dilution is made by the addition of 0·1 cubic centimetre of the stock solution to 9·9 cubic centimetres of sterile distilled water. Of this dilution varying amounts, as estimated by experiment, are added to tubes containing five cubic centimetres peptone water. The latter reacts faintly alkaline to litmus and is prepared in the ordinary way.

Method of Employment.

Our first series of experiments, as illustrating the procedure adopted throughout, is fully set forth in Table I. Fresh broth cultures of the organisms under investigation, whose biological characters had been previously fully determined (in this case the *B. coli* and *B. typhosus*) were made and incubated for twenty-four hours. The developing organisms were then enumerated and mixtures, varying from equal number of either organism to 1 *B. typhosus* in 100 *B. coli*, were directly put up in ten cubic centimetres of saline; 0·5 cubic centimetre of each mixture was then successively introduced into each of the four peptone water tubes, the first of which contained no brilliant green, the others respectively 0·3, 0·5, 0·7 cubic centimetre of the 1 in 10,000 dilution. At the same time 0·5 cubic centimetre of either broth culture, diluted ten times, was added to two series of four tubes (Plate series I and II) and together with a third series (Plate series VII) in which the *B. typhosus* preponderated in the proportion of fifty to one were incubated with the remainder. After a further period of twenty-four hours the tubes in which growth was manifest were removed from the incubator and, depending upon the density of

the growth, were either plated directly by the addition of 0·005 or 0·0025 cubic centimetre to the surface of MacConkey's medium (which was spread with a glass rod) or were proportionately diluted before doing so. The plates were then incubated over-night, and the number of developing colonies determined.

TABLE I.

COMPARATIVE DEVELOPMENT OF *B. typhosus* AND *B. coli* IN BRILLIANT GREEN MEDIA.

Plate series No.	Proportion of *B. typhosus* to *B. coli* inoculated in peptone water	Amount of brilliant green (1 in 10,000) in c.c., in 5 c.c. peptone water	Resulting growth on MacConkey's medium
I	Pure *B. typhosus* ..	0	155 colonies.
		0·3	Confluent growth.
		0·5	No growth in forty-eight hours.
		0·7	,, ,, ,, ,,
II	Pure *B. coli*	0	2,000 colonies.
		0·3	Confluent growth.
		0·5	No growth in forty-eight hours.
		0·7	,, ,, ,, ,,
III	1 : 1	0	Confluent growth of *C*; 28 colonies of *T*.
		0·3	Confluent growth; almost pure *T*.
		0·5	Pure growth of *T*.
		0·7	No growth in forty-eight hours.
IV	1 : 10	0	Confluent growth of *C*; 10 colonies of *T*.
		0·3	Almost pure *T*.
		0·5	Pure growth of *T*.
		0·7	No growth in forty-eight hours.
V	1 : 50	0	Discrete pure growth of *C*.
		0·3	Confluent growth; almost pure *T*.
		0·5	,, ,, ,, ,,
		0·7	No growth in forty-eight hours.
VI	1 : 100	0	770 colonies of *C*; 2 colonies of *T*.
		0·3	Mass of growth consists of *C*, but numerous colonies of *T* present.
		0·5	No growth in forty-eight hours.
		0·7	,, ,, ,, ,,
VII	50 : 1	0	110 colonies of *C*; 38 colonies of *T*.
		0·3	Pure growth of *T*.
		0·5	,, ,, ,,
		0·7	No growth in forty-eight hours.

C = *B. coli*. *T* = *B. typhosus*.

All the control peptone water tubes represented by the 0 of each series were diluted 1,000 times before plating. The remainder, in which the growth was comparatively scanty, were undiluted.

DIFFERENTIAL BACTERICIDAL ACTION ON *B. coli* AND *B. typhosus*.

As will be seen (Table I) although it was found possible to isolate the *B. typhosus* on that plate of the No. VI series (VI, 0) to which no brilliant green had been added, the isolation must be regarded as a fortuitous circumstance. For we have frequently failed to do so even when the peptone water received a proportionately considerably higher inoculation with *B. typhosus*; and, it will be observed, that by the addition of brilliant green the isolation was markedly facilitated. The No. VII series is of interest as showing that on plating from peptone tubes which had been inoculated with a mixture of fifty *B. typhosus* to one *B. coli*, while the addition of brilliant green induced a pure growth of *B. typhosus*, in the absence of the dye a preponderance of *B. coli* in the proportion of three to one was obtained.

COMPARISON WITH MALACHITE GREEN.

Comparing these results with those afforded by an identical series of experiments with malachite green, the inferiority of the latter to brilliant green as an enhancing agent was manifest. For it was not found possible by means of malachite green to isolate the *B. typhosus* when the *B. coli* was in excess by more than ten to one.

RESISTANCE OF THE PARATYPHOID GROUP.

The comparative viability of the *B. coli* and the *B. paratyphosus* A were similarly investigated. In these cases, however, with a view to obtaining as far as possible discrete colonies, the MacConkey medium was heated to boiling point, gradually cooled to 43° C. and inoculated with 0·005 cubic centimetre of the peptone water culture before pouring on Petri dishes. The results afforded by malachite and brilliant greens closely approximated. (Tables II and III.)

The enhancing property of brilliant and malachite greens is well illustrated by Tables IV and V. In either case a pure growth of *B. paratyphosus* B was obtainable from peptone water cultures which had been inoculated from a mixture in which *B. coli* preponderated by 100 to 1.

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TABLE II.

COMPARATIVE DEVELOPMENT OF *B. paratyphosus* A AND *B. coli* IN BRILLIANT GREEN MEDIA.

Plate series No.	Proportion of *A* to *C* inoculated in peptone water	Amount of brilliant green (1 in 10,000) in c.c., in 5 c.c. peptone water	Resulting growth on MacConkey's medium
I	Pure *B. paratyphosus* A	0	Confluent growth and numerous discrete colonies.
		0.3	Confluent growth and numerous discrete colonies.
		0·5	Discrete but uncountable growth.
		0·7	Confluent growth.
II	Pure *B. coli*	0	Confluent growth.
		0·3	Small area of confluent growth and 7 discrete colonies.
		0·5	Small area of confluent growth and 12 discrete colonies.
		0·7	No growth.
III	1 : 1	0	Confluent growth of *C*; no *A*.
		0·3	Small confluent area of *C*; no *A*.
		0·5	1 colony of *C*; no *A*.
		0·7	3 colonies of *C*; no *A*.
IV	1 : 10	0	4 colonies of *C*; no *A*.
		0·3	14 colonies of *C*; thick confluent growth of *A*.
		0·5	11 colonies of *C*; thick confluent growth of *A*.
		0·7	11 colonies of *C*; thick confluent growth of *A*.
V	1 : 50	0	2 small areas of *C* and *A*.
		0·3	A few deep colonies of *C*; thick confluent growth of *A*.
		0·5	20 colonies of *C*; large confluent growth of *A*.
		0·7	200 colonies of *C*; large confluent growth of *A*.
VI	1 : 100	0	Confluent growth of *C*; 3 small areas of *A*.
		0·3	A few confluent areas of *C*; thick growth of *A*.
		0·5	A few discrete colonies of *C* and *A*.
		0·7	A few discrete colonies of *C*; large confluent growth of *A*.
VII	50 : 1	0	A few colonies of *C*; thick confluent growth of *A*.
		0·3	Numerous discrete colonies of *C*; thick confluent growth of *A*.
		0·5	Pure growth of *A*.
		0·7	,, ,,

C = *B. coli*. *A* = *B. paratyphosus* A.

All the control peptone water tubes represented by the 0 in each series were diluted 1,000 times before plating. The remainder were undiluted.

TABLE III.

Comparative Development of *B. paratyphosus* A and *B. coli* in Malachite Green Media.

Plate series No.	Proportion of *A* to *C* inoculated in peptone water	Amount of malachite green (1 in 10,000) in c.c., in 5 c.c. peptone water	Resulting growth on MacConkey's medium
I	Pure *B. paratyphosus* (A)	0	Thick confluent growth.
		0·3	,, ,, ,,
		0·5	,, ,, ,,
		0·7	,, ,, ,,
II	Pure *B. coli*	0	Thick confluent growth.
		0·3	,, ,, ,,
		0·5	,, ,, ,,
		0·7	,, ,, ,,
III	1 · 1	0	Thick growth of *C*; scanty confluent growth of *A*.
		0·3	Confluent growth of *C*; small confluent area of *A*.
		0·5	Almost pure growth of *A*.
		0·7	Pure growth of *A*.
IV	1 : 10	0	Thick growth of *C*; few colonies of *A*.
		0·3	170 colonies of *C*; confluent growth of *A*.
		0·5	140 ,, of *C*; ,, ,, of *A*.
		0·7	135 ,, of *C*: ,, ,, of *A*.
V	1 : 50	0	Pure confluent growth of *C*.
		0·3	280 colonies of *C*; confluent growth of *A*.
		0·5	133 ,, of *C*; ,, ,, of *A*.
		0·7	47 ,, of *C*; ,, ,, of *A*.
VI	1 : 100	0	Confluent growth of *C*; 2 colonies of *A*.
		0·3	,, ,, of *C*; 45 ,, of *A*.
		0·5	46 colonies of *C*; thick confluent growth of *A*.
		0·7	55 colonies of *C*; thick confluent growth of *A*.
VII	50 : 1	0	Scanty growth of *C*; thick growth of *A*.
		0·3	68 colonies of *C*; thick growth of *A*.
		0·5	Almost pure growth of *A*.
		0·7	,, ,, ,,

C = *B. coli*. *A* = *B. paratyphosus* A.

All the control peptone water tubes represented by the 0 in each series were diluted 1,000 times before plating. The remainder were undiluted.

Viability of the *B. dysenteriæ* (Shiga and Flexner).

Our final investigation was concerned with the viability of the dysentery bacilli (Shiga and Flexner). Both strains, however, offer considerably less resistance to the action of either brilliant or malachite green than does the *B. coli* by which they are immediately overgrown.

TABLE IV.

Comparative Development of *B. paratyphosus* B and *B. coli* in Brilliant Green Media.

Plate series No.	Proportion of *B* to *C* inoculated in peptone water	Amount of brilliant green (1 in 10,000) in c.c., in 5 c.c. peptone water	Resulting growth on MacConkey's medium
I	Pure *B. paratyphosus* B	0	Confluent growth.
		0·3	,, ,,
		0·5	Thick growth.
II	Pure *B. coli*	0	Thick confluent growth.
		0·3	Small confluent area of growth.
		0·5	No growth in forty-eight hours.
III	1 : 1	0	145 colonies of *C*; confluent growth of *B*.
		0·3	Pure confluent growth of *B*.
		0·5	,, ,, ,, ,,
IV	1 : 10	0	343 colonies of *C*; 21 colonies of *B*.
		0·3	Pure confluent growth of *B*.
		0·5	,, ,, ,, ,,
V	1 : 50	0	Thick confluent growth of *C* and *B*.
		0·3	Pure confluent growth of *B*.
		0·5	Pure discrete growth of *B* (287 colonies).
VI	1 : 100	0	Pure growth of *C* (22 colonies).
		0·3	Pure confluent growth of *B*.
		0·5	Confluent growth of *B*: 2 colonies of C.
VII	50 : 1	0	52 colonies of *C*; confluent growth of *B*.
		0·3	Pure confluent growth of *B*.
		0·5	,, ,, ,, ,,

C = *B. coli*. *B* = *B. paratyphosus* B.

Conclusions.

The conclusions, then, to which the foregoing series of experiments seem to point are:—

(1) That the *B. typhosus* offers considerably greater resistance to the inhibitory action of brilliant green than does the *B. coli* and

TABLE V.

COMPARATIVE DEVELOPMENT OF *B. paratyphosus* B, AND *B. coli* IN MALACHITE GREEN MEDIA.

Plate series No.	Proportion of *B* to *C* inoculated in peptone water	Amount of malachite green (1 in 10,000) in c.c., in 5 c.c. peptone water	Dilution of cultures before plating	Resulting growth on MacConkey's medium
I	Pure *B. paratyphosus* B	0	1,000	16 colonies.
		0·3	1,000	9 ,,
		0·5	100	3,100 ,,
		0·7	–	3,840 ,,
II	Pure *B. coli* ..	0	1,000	160 colonies.
		0·3	100	1,520 ,,
		0·5	–	4,600 ,,
		0·7	–	1,920 ,,
III	1 : 1	0	1,000	952 colonies of *C*; 40 colonies of *B*.
		0·3	–	4 ,, of *C*; confluent growth of *B*.
		0·5	100	Pure growth of *B*.
		0·7	100	,, ,, ,,
IV	1 : 10	0	1,000	154 colonies of *C*; 16 colonies of *B*.
		0·3	100	616 ,, of *C*; confluent growth of *B*.
		0·5	100	210 colonies of *C*; confluent growth of *B*.
		0·7	–	9 colonies of *C*; 1,200 colonies of *B*.
V	1 : 50	0	1,000	102 colonies of *C*; 4 colonies of *B*.
		0·3	100	36 ,, of *C*; 880 ,, of *B*.
		0·5	100	5 ,, of *C*; thick growth of *B*.
		0·7	–	8 ,, of *C*; ,, ,, of *B*.
VI	1 : 100	0	1,000	No growth.
		0·3	100	232 colonies of *C*; 112 colonies of *B*.
		0·5	100	50 ,, of *C*; thick growth of *B*.
		0·7	–	Pure confluent growth of *B*.
VII	50 : 1	0	1,000	5 colonies of *C*; no *B*.
		0·3	100	68 ,, of *C*; 2,300 colonies of *B*.
		0·5	100	4 ,, of *C*; 783 ,, of *B*.
		0·7	–	4 ,, of *C*; thick growth of *B*.

C = *B. coli*. *B* = *B. paratyphosus*. – = undiluted.

that consequently in mixtures of these organisms its employment is of great value in facilitating the isolation of the former.

(2) That malachite green possesses this property to a very much lesser extent.

(3) That malachite and brilliant greens are about equally efficacious in the isolation of the paratyphoid group of bacilli, but that in the investigation of infected material, the causal organism of which infection is unknown, in view of the greater resistance offered by the *B. typhosus* to brilliant green, the employment of the latter dye is indicated.

(4) That in view of the great susceptibility of the dysentery bacilli (Shiga and Flexner) to the bactericidal action of both brilliant and malachite greens, in determining the presence of these organisms in infected material the employment of either dye is contraindicated.

ADDENDUM.

The Use of Brilliant Green in the Routine Examination of Fæces.

Brilliant green peptone water is now in use in this hospital in the routine examination of fæces. It occurs not infrequently that paratyphoid bacilli are isolated from brilliant green when the broth cultures are negative. It has happened several times that a pure culture of paratyphoid has been obtained from brilliant green while the broth cultures gave none. When large numbers of cases have to be examined, it is not possible to use a series of tubes with varying strengths of brilliant green, but the practical results obtained show that this is not necessary as a routine. If typhoid and paratyphoid were the sole pathogenic bacilli to be considered it would be sufficient to take cultures of the fæces into brilliant green alone, but at the present time the occurrence of dysentery bacilli render it necessary to take cultures into simple broth also, since these bacilli do not grow well in brilliant green and would usually be missed. Broth cultures have to be plated on the same day, but the brilliant green tube needs incubation for at least twenty-four hours. This difference renders it possible to adopt a routine in which the additional use of brilliant green entails no greater time, or but little more than the use of broth alone, for if typhoid or paratyphoid bacilli be isolated from the broth culture it is unnecessary to go further with the brilliant green tube. It occurs sometimes that a yellow colony or a patch of yellow is in a position

in which it is difficult to pick it off without contamination with *B. coli.* In such cases isolation may often be effected simply by subculturing into brilliant green peptone water, incubating over-night and replating.

The following routine is now in use:—

First Day.—Cultures from stools are taken into: (i) Broth, (ii) Peptone water, five cubic centimetres to which has been added 0·25 cubic centimetre of a 1 in 10,000 solution of brilliant green.

These cultures are placed in the incubator. After two to six hours' incubation the broth culture is plated on MacConkey's medium. The brilliant green tube is left in the incubator over-night.

Second Day.—The MacConkey plates from both are examined: (i) If yellow or suspicious colonies are present, a selection of these is picked off, placed in broth tubes and incubated until the evening. Subcultures are then made into the carbohydrate and other differentiating media. The brilliant green culture is not plated. (ii) If only red colonies are present, the brilliant green culture is plated on MacConkey's medium.

Third Day.—(i) If subcultures have been made on the previous day from the broth MacConkey plates, these are examined. If typhoid or paratyphoid bacilli are found, the brilliant green culture need not be proceeded with. If these bacilli are not present, the brilliant green culture is plated. (ii) If the brilliant green culture has been plated on the second day, the plates are examined for suspicious colonies and these are subcultured. If none are present, the stool is considered to be "negative."

Fourth and subsequent Days.—If the brilliant green has been plated on the third day the plates are examined on the fourth. Subcultures on differentiating media are watched for the identifying changes. If any suspicious colonies are present, these are sub-cultured.

Results Obtained in a Series of Cases.

The results may be given from a series of 200 consecutive cases. This series includes cases from the general and surgical wards of which stools were examined for diagnostic purposes, but for simplification cases are omitted in which more than one pathogenic bacillus was found. Almost all the cases came from the Mediterranean.

The results of this series are :—

B. typhosus	in 5 cases.
B. paratyphosus A	,, 51 ,,
,, ,, B	,, 64 ,,
B. dysenteriæ (Shiga)	,, 12 ,,
,, ,, (Flexner)	,, 8 ,,
Negative	,, 60 ,,

In fifteen cases *B. paratyphosus* A and in eleven cases *B. paratyphosus* B was isolated from brilliant green when the broth cultures were negative. In this series the positive cases are raised from fifty-seven per cent to seventy per cent by the use of brilliant green. The effect is more marked with *B. paratyphosus* A than with B. This agrees with the results of the examination of individual stools. In 100 consecutive stools from which *B. paratyphosus* A was isolated, there were 36 instances in which it was obtained only from brilliant green, and in 100 consecutive stools from which *B. paratyphosus* B was isolated, there were 21 such instances. *B. paratyphosus* A appears to be more difficult to recover from a broth culture than is *B. paratyphosus* B and the use of brilliant green is of greater value for its isolation.

Dysentery bacilli were isolated four times from brilliant green, but in no case when they had not been obtained from broth nor, in this series, did any such instance occur in the cases in which *B. typhosus* was isolated. These latter were too few to afford any measure of the value of brilliant green in the isolation of *B. typhosus*, but there is no doubt that it must not be relied upon for the isolation of dysentery bacilli.

This series confirms the result obtained by Dr. C. Browning, that brilliant green simplifies the isolation of paratyphoid and typhoid bacilli and will frequently lead to their detection when broth cultures are negative. It is of special value for the isolation of *B. paratyphosus* A.

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Clinical and other Notes.

GUNSHOT WOUND OF PERICARDIUM AND HEART; PNEUMO-HÆMOPERICARDITIS; OPERATION; RECOVERY.

By Major L. JONES.
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Pipe-Major T., K.O.S.B., aged 38, was wounded on October 1, 1915, by high explosive shell, and admitted to our hospital on the 3rd, with two shell wounds of the chest-wall and one of the left forearm. His pulse-rate was 77, respiration-rate 32.

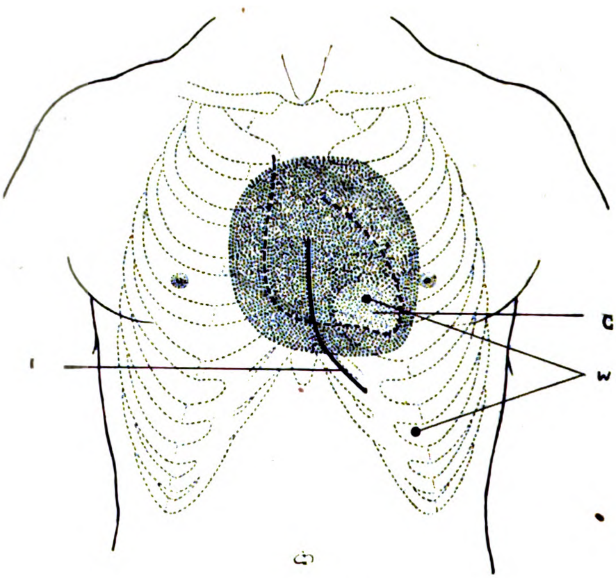
Of the two wounds of the left chest wall one was in the fourth intercostal space three inches internal to the nipple line, the other in the seventh space two inches outside the nipple line. The wounds were—as usual—infected. The fragments of shell had penetrated the chest wall. The wound in the arm was explored and a fragment of shell removed.

The patient was expectorating blood. The breath sounds were faint and impaired over the left base. The heart sounds were very faint. There were dyspnœa, and great complaint of inability to sleep. Dullness extended across the chest from one base to the other, and both pleural cavities were suspected of harbouring fluid.

Four days later the patient had not slept, or, if at all, only for the briefest intervals; the cardiac sounds had entirely disappeared, so much so that another stethoscope was asked for on the supposition that the one in use was blocked. The pulse-rate and volume were much the same, but the patient was dusky, much distressed at the inability to sleep, and he complained of a stretching pain at the back of the left chest. He was too ill for an examination of his back. A stimulating expectorant was administered, and the blood-stained expectoration had ceased by the sixth day.

On the eighth day he was more exhausted by loss of sleep. His sclerotics were icteric. His pulse-rate averaged 70 and his temperature was normal. There was no œdema of the chest wall such as I have twice since seen in hæmopericarditis. Although the man was very ill, on Captain Hayward's suggestion he was taken on his bed to the X-ray room and screened in the "sitting up" position, which he favoured, to confirm the diagnosis of pericarditis and to ascertain the condition of the pleural cavities. It was at once apparent that the extensive dullness was sharply localized and due to an extensive pericardial effusion. Also it was apparent that there was little—if any—hæmothorax. An X-ray plate was taken in this difficult position, and the drawing taken from it illustrates the condition.

The patient being in great distress, it was obvious that either fresh hæmorrhage had taken place or that infection had occurred. An operation to expose the pericardium and heart was decided upon. Ether anæsthesia was induced. The incision made was that following the border of the seventh costal cartilage and the mid-line of the sternum; portions of the seventh, sixth, and fifth costal cartilages were removed and half the width of the sternum, thus giving one sufficient room to introduce at least two fingers and a thumb to grasp the heart if the necessity arose if it were still bleeding, or recommenced to bleed, and steady the organ for suture.



The pericardium, being well exposed, was incised vertically for two inches, and the heart at once plugged the wound.

On pushing that organ backwards a large quantity of foul-smelling gas escaped, followed by froth, and, later, stinking fluid, which was blood-stained. We estimated the amount of gas that escaped as being as much as would displace six ounces of water. The fluid, which had a most foul smell, measured twenty-two ounces. The pathological report on it was that *Bacillus perfringens* and enterococci were grown, also a few staphylococci.

The fingers were at once introduced into the sac and adhesions separated between the heart and the floor and wall of the pericardium. The foreign body was not in the pericardium, but had guttered the anterior and upper border of the heart, and penetrated the sac wall and pleura and entered the left lung. There was no recent hæmorrhage.

Only the most careful examination of the injured area of the sac wall was made, so as to avoid infecting the pleura if it were fortunately sealed off, as we had reason, to believe was the case from the X-ray screening.

The patient's colour, which had—up to the moment of opening the pericardium—been dusky and dull, at once assumed a healthy aspect and his pulse became stronger.

The fluid and blood from the breaking down of adhesions were mopped out, and a flanged rubber drain introduced through eusol dressings into the pericardial sac. The heart itself was tolerant of manipulations, and remained so during the subsequent dressings. Part of the wound in the chest wall was sutured together. The patient, much relieved by the operation, was put back to bed.

The pericardial cavity was syringed out with warm eusol, which certainly acts as a great deodorant. Large quantities of lymph (which coagulated) formed, and this had to be picked out at every dressing with forceps. The eusol caused some pain. Hypertonic saline was tried, but caused great pain, the pain being always referred to the middle of the back. Saline solution of normal strength was tried, but was also complained of. Iodine solution, one dram to the pint, however, suited him at once, and this strength—or two drams to the pint—was used until the wound had entirely healed, which occurred in seven weeks.

One piece of tough coagulated lymph resembled a cast of the posterior part of the pericardial sac. Pushing the heart out of the way caused no sensation or distress, and he was unconscious of the movement.

The X-ray plate shows distinctly the much-distended pericardial cavity and its almost circular shape, and the more transparent area towards the centre of the opacity due to the contained gas, which was not suspected before operation. The entire absence of heart sounds before operation was a most conspicuous clinical feature.

The congestion of both bases suggested some fluid—the right base was more suspected than the left. Owing to the large quantity of gas and fluid in the pericardium one had anxiety that when the sac contracted infected material would remain in the posterior part of the right recess of the pericardium, and that the healing and closing of the wound would add still further to one's difficulty. At one time I considered the possibility of draining the pericardium from behind, and if the left lung had been collapsed, would have had, I think, little difficulty. On a few occasions a catheter was introduced behind the heart and the fluid sucked out. I was unable to procure a saliva exhauster at the time. The cavity was always filled with lotion at body heat and the heart churned it up with the fragments of lymph, and cavity was mopped out repeatedly until the lotion remained clear.

There is one point in dealing with costal cartilages that is worth bearing in mind, and that is that they heal slowly and are best sectioned as short as is possible, leaving them undisturbed in their perichondrium

and concave. If left protruding from their membrane they heal slowly.

Pericardicentesis, judged by the numerous "best spots" given by different authors, is unreliable apart from the usual danger. In this case there was the added risk of sepsis, and had a trocar or aspirating needle been introduced and the heart not punctured, as it would almost certainly have been, gas or froth would have been withdrawn. Possibly the pleura would have been suspected, as gas in the pericardium is certainly unusual. The pleural cavity never became infected.

During the convalescence of the patient the base of his left lung gave us some anxiety. His urine at one time only measured twelve ounces in the twenty-four hours and œdema of the loins was present, but the albuminuria was slight in amount. At this time his pulse became barely perceptible, but never alarmingly frequent.

There have been many discussions as to the position of the heart in pericardial effusions. In this case the heart was anterior and in close contact with the chest wall, and this in the presence of a large effusion of gas and fluid.

In two other recent cases of hæmopericarditis due to gunshot wounds where expectant treatment proved successful, the heart sounds could only be heard at the base of the heart over the sternum in one, and only very faintly in the other; but I have no evidence to offer as to whether the heart was more anterior than posterior.

Tho wound has long since firmly healed and Captain MacIlwane has kindly examined the patient by the electrocardiograph.

Examination of Cardiac Condition, January 16, 1916.

"There was no evidence of any hypertrophy or dilatation being present. No murmurs were heard; none of the cardinal signs of adherent pericardium were observed. The systolic blood-pressure was 108 millimetres of mercury, and the diastolic pressure eighty-five millimetres by auscultatory method. The electrocardiogram showed a regular rhythm with no abnormal mechanism of beat except a slight inversion of the T wave in lead II. It was difficult to map out the left margin of the heart at the apex as the cardiac dullness was continuous with the dull area in the axillary region. An X-ray plate taken by Captain Crymble showed that there was no increase in the size of the heart."

The patient has apparently every chance of regaining robust health judging by his progress here in France and a report from home. He enjoys short walks, his urine is normal, he has no œdema of the ankles and, in short, has regained, so far as is possible to say, his former condition.

I would like to thank my colleagues and the nursing staff for their help in this case. The skilful dressing of this patient, which was of frequent occurrence by night as well as day, probably just made the difference.

THROMBOSIS OF THE CEREBRAL ARTERIES IN PARATYPHOID B.

By WILLIAM MACADAM, M.D., B.Sc.. D.P.H.(Camb.).
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In view of the fact that paratyphoid B fever is generally held to be a much milder infection than enteric fever, and of the rarity of thrombosis of the cerebral arteries as a complication of the latter disease, the following case, with post-mortem and bacteriological notes, has been thought worthy of record.

The patient, aged 25 years, a corporal in an Australian unit was admitted into hospital from Gallipoli on September 26, 1915, in a semi-comatose condition while he showed all the signs and symptoms of the "typhoid state." No history could be obtained from the man, but some scanty notes accompanying the patient indicated that the cerebral symptoms had been of at least six days duration, while the temperature on hospital ship had ranged between 102° F. and 104° F.

Examination on admission showed the patient to be suffering from complete right-sided hemiplegia and right facial paralysis. The limbs were quite limp and flaccid, with complete absence of reflexes. Babinski nil. There was incontinence of urine and fæces. The spleen showed considerable enlargement, extending to a hands' breadth below the costal margin. No paralytic signs were observed on the left side. Coma gradually deepened, patient dying two days after admission.

Necropsy.—Post-mortem examination of the brain revealed the following: The dura mater was markedly adherent over the calvarium while its vessels were unduly congested. No thrombi were found in the cerebral sinuses, although some loose attenuated clots were present. The leptomeninges appeared normal. The left cerebral hemisphere showed slight flattening but there was no marked œdema. Examination of the vessels at the base of the brain revealed the presence of thrombosis at the upper end of the left internal carotid artery extending into the middle meningeal artery and its lenticulo-optic and lenticulo-striate branches. This was well seen as they passed into the anterior perforated space, and was continued into the external segment of the lenticular nucleus where the arteries became whitish in colour, and somewhat attenuated in size. An area of cerebral softening, of reddish-white colour, and of the size of a pigeon's egg, involved the internal capsule and lenticular nucleus. On the right side the junction of the internal carotid and middle meningeal arteries was normal, as was also the first part of the latter vessel from which the perforating branches arise, but beyond this, and especially in the cortical branches thrombosis was present. No softening or other abnormal character of the cerebral tissue was detected in the right hemisphere.

The spleen was about four times its normal size, there being a large swelling at either pole with a relatively constricted part in the middle. Those swellings were due to large hæmorrhagic infarcts and showed signs of purulent softening. The wall of the small intestine showed considerable congestion, the hyperæmia becoming more marked in the lower part of the ileum. Ulceration was slight, and was confined to the Peyer's patches of the lowest three feet of the ileum. Except for hyperæmia of the mucous membrane of the cæcum the great intestine appeared normal. The mesenteric glands were considerably enlarged and hyperæmic. Thus the general toxæmia was altogether a more marked feature than the local lesion.

The nature of the infection was confirmed bacteriologically at the autopsy by the isolation in pure culture from the spleen of a Gram-negative bacillus with all the cultural and agglutinating characters of *Bacillus paratyphosus* B.

I desire to express my indebtedness to my Commanding Officer, Lieutenant-Colonel A. W. Sheen, for his permission to publish the record of the above case.

ON THE BACTERICIDAL EFFECT EXERTED *IN VITRO* BY ETHYLHYDROCUPREINE (OPTOCHIN) HYDROCHLORIDE ON A FÆCAL STREPTOCOCCUS OBTAINED FROM WOUNDS.

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(*A Report to the Medical Research Committee.*)

Ethylhydrocupreine (optochin) is an alkaloid derived from cuprea bark. It is the methyl derivative of quinine which has been reduced by the introduction of a further two hydrogen groups. Its chemical formula is $C_2IH_{23}N_2O_2$. The hydrochloride is a white crystalline powder, is soluble one in ten of water, the diluted solution showing a bluish fluorescence. It is neutral to litmus and has an intensely bitter taste. It can be administered by the mouth or subcutaneously in doses of one to two grammes (fifteen to thirty grains) daily. In view of the fact that cases of amaurosis and ambliopia have been reported after administration of the drug these doses should not be exceeded. It was studied by Morgenroth in 1911 as a pharmaco-therapeutic agent in experimental pneumococcal septicæmia in mice. It was shown to possess very considerable bactericidal powers, and was able to protect over ninety per cent of artificially inoculated animals against infection by the pneumococcus. In 1912 Sir A. E. Wright carried out a number of *in vitro*

experiments with optochin hydrochloride in connexion with work on pneumonia, and was able to demonstrate that it retained its bactericidal effect on the pneumococcus in the presence of blood and serum when diluted two million-fold. In view of these very striking bactericidal results, and owing to the general resemblance of the fæcal streptococcus (enterococcus) which is recoverable from most infected wounds in the present war, Sir A. E. Wright suggested to me the advisability of investigating the bactericidal power of optochin in the case of the enterococcus. The bacterial emulsion used in all the following experiments was a dilution of a twenty hours' broth culture of a fæcal streptococcus recovered from pus from a recently infected wound. In *freshly prepared* aqueous solution, left in contact with the microbes for twenty hours at 37° C., optochin kills the enterococcus in two million-fold dilution, as is shown in the following experiment :—

EXPERIMENT 1.

Streptococcus emulsion	Optochin hydrochlor.	Water	Colonies after 37°C., 24 hours
1 loopful ..	10 c.mm. 1/200 ..	– ..	0
,, ..	10 ,, 1/2,000 ..	– ..	0
,, ..	10 ,, 1/20,000 ..	– ..	0
,, ..	10 ,, 1/200,000 ..	– ..	0
,, ..	10 ,, 1/400,000 ..	– ..	0
,, ..	10 ,, 1/1,000,000 ..	– ..	1
,, ..	10 ,, 1/2,000,000 ..	– ..	10
,, ..	– ..	10 c.mm. ..	∞

Contact 37° C., 20 hours

It is necessary to emphasize the words "freshly prepared" for it was found that exposure to light soon diminished the bactericidal activity of the solution as may be seen in the following experiment :—

EXPERIMENT 2.

Streptococcus emulsion	Optochin hydrochlor.	Sterile water	Colonies after Contact 20 hours: Solution kept in the dark	Solution exposed to light 4 hours	Three days old
1 loopful ..	10 c.mm. 1/20 ..	– ..	0 ..	0 ..	0
,, ..	10 ,, 1/200 ..	– ..	0 ..	0 ..	0
,, ..	10 ,, 1/2,000 ..	– ..	0 ..	0 ..	0
,, ..	10 ,, 1/20,000 ..	– ..	0 ..	0 ..	∞
,, ..	10 ,, 1/200,000 ..	– ..	0 ..	0 ..	∞
,, ..	10 ,, 1/400,000 ..	– ..	0 ..	10 ..	∞
,, ..	10 ,, 1/1,000,000 ..	– ..	1 ..	∞ ..	∞
,, ..	10 ,, 1/2,000,000 ..	– ..	10 ..	∞ ..	∞
,, ..	– ..	10 c.mm. ..	∞ ..	∞ ..	∞

In human serum optochin kills the enterococcus in a concentration of 1 in 400,000. Further, and this is additional evidence that its activity is not quenched by serum, the action of the drug becomes more evident the longer it is allowed to remain in contact with serum and bacteria. These points will be appreciated by reference to experiments 3, 4, and 5.

EXPERIMENT 3.

Streptococcus emulsion	Human serum	Optochin hydrochlor.	NaCl.	Colonies after 37° C., 15 hours
1 c.mm.	10 c.mm.	10 c.mm. 1/20	–	0
1 ,,	10 ,,	10 ,, 1/200	–	0
1 ,,	10 ,,	10 ,, 1/2,000	–	69
1 ,,	10 ,,	10 ,, 1/20,000	–	207
1 ,,	10 ,,	10 ,, 1/200,000	–	∞
1 ,,	10 ,,	10 ,, 1/2,000,000	–	∞
1 ,,	10 ,,	–	10 c.mm.	∞

Contact 5 hours, 37° C.

EXPERIMENT 4.

Streptococcus emulsion	Human serum	Optochin hydrochlor.	NaCl.	Colonies after 37° C., 20 hours
1 c.mm.	10 c.mm.	10 c.mm. 1/20	–	0
1 ,,	10 ,,	10 ,, 1/200	–	0
1 ,,	10 ,,	10 ,, 1/2,000	–	0
1 ,,	10 ,,	10 ,, 1/20,000	–	0
1 ,,	10 ,,	10 ,, 1/200,000	–	0
1 ,,	10 ,,	–	10 c.mm.	4,680

Contact 20 hours, 37° C.

EXPERIMENT 5.

Strepto-coccus emulsion	Human serum	Optochin hydrochlor.	NaCl.	Not incu-bated	Colonies after Contact, 37° C. for— 1 hour	3 hours	16 hours
1 c.mm.	10 c.mm.	10 c.mm. 1/20	–	–	0	0	0
1 ,,	10 ,,	10 ,, 1/200	–	–	0	0	0
1 ,,	10 ,,	10 ,, 1/2,000	–	–	640	207	0
1 ,,	10 ,,	10 ,, 1/20,000	–	–	1,340	210	78
1 ,,	10 ,,	10 ,, 1/200,000	–	–	ca. 1,300	2,414	582
1 ,,	10 ,,	10 ,, 1/1,000,000	–	–	,,	3,480	∞
1 ,,	10 ,,	–	10 c.mm.	1,972	,,	4,920	∞

Experiments have shown that in dilutions which are affective against microbes optochin does not interfere with phagocytosis or with the emigration of leucocytes. Its close congener quinine also possesses bactericidal properties for the enterococcus though to a much smaller degree, as is shown in experiment 6.

EXPERIMENT 6.

Strepto-coccus emulsion	Human serum	Quinine hydrochlor.	NaCl.	Not incu-bated	Colonies after Contact, 37° C. for— 1 hour	3 hours	16 hours
1 loopful	10 c.mm.	10 c.mm. 1/20	–	–	0	0	0
,,	10 ,,	10 ,, 1/200	–	–	0	0	0
,,	10 ,,	10 ,, 1/2,000	–	–	444	1,700	0
,,	10 ,,	10 ,, 1/20,000	–	–	800	4,800	∞
,,	10 ,,	10 ,, 1/200,000	–	–	ca. 850	ca. 5,000	∞
,,	10 ,,	10 ,, 1/2,000,000	–	–	,,	,,	∞
,,	10 ,,	–	10 c.mm.	118	,,	,,	∞

Optochin has very limited powers of penetration as was demonstrated by superimposing a 1 in 1,000 solution on an infected column of clotted centrifuged blood in an emigration tube. After ten hours the solution had only succeeded in penetrating to a depth of $\frac{1}{5}$ millimetre. Below this depth the microbes had grown with undiminished vigour. This fact would seriously limit its efficacy in the treatment of bacterial infections for it would be unable to diffuse into and exert its influence in abscess cavities, infiltrated tissues (such as would be found in croupous pneumonia and wound infections) and other dead spaces. It would appear that it might find its useful sphere of application in cases of streptococcal bacteriæmia. But opportunity of putting this to the test has not yet been offered.

In conclusion it is a pleasant duty to acknowledge my indebtedness to Colonel Sir A. E. Wright and to the Medical Research Committee under whose auspices this work was carried out.

ACUTE HODGKIN'S DISEASE WITH INVOLVEMENT OF INTERNAL GLANDS AND RELAPSING PYREXIA.

By Lieutenant T. H. WHITTINGTON.
Royal Army Medical Corps.

The following case is worthy of publication for three reasons. In the first place the general course, amongst other peculiarities, presented a combination of an acute onset in an "internal" form of the disease with a relapsing pyrexia and signs and symptoms chiefly abdominal. Secondly, it formed an interesting problem in diagnosis, and the endeavours to solve this gave rise to much speculation, for the case deceived the very elect. Finally, at the post-mortem many interesting pathological features were discovered, and only then was the diagnosis settled.

In McNalty's study of "Lymphadenoma with Relapsing Pyrexia" (*Quarterly Journal of Medicine*, October, 1911), of thirty-two cases there were eight without enlargement of the superficial glands. Only two of these had a shorter duration than the case here reported. One, a male, aged 23, with involvement of mediastinal glands, spleen, liver and kidney, died in five weeks; the other, also recorded by Dreschfeld, had enlargement of the mesenteric and bronchial glands, the liver and spleen, and lived seven weeks. The others lived periods varying from four to fifteen months.

Description of Case.

Onset.—Private L., aged 19, reported sick on November 21, for "Frost Bite," occurring in the trenches in Flanders. He was admitted to a Base Hospital for this complaint on November 23.

On admission, the patient looked pale and complained of pains in toes and soles of feet, but nothing abnormal was seen in these parts. The temperature and pulse-rate were normal. He was badly constipated and therefore was given a strong aperient pill. Two hours later he complained of severe abdominal pain mostly in the right side. The abdomen was then tender, held rigid, but not absolutely so, and moved slightly with respiration. The patient's temperature and pulse-rate were raised, and during the next few hours he vomited two or three times.

The appearance of the case was suggestive of peritonitis, but no localized tender or dull spot could be made out, and the patient's general condition being good the case was carefully watched without resort to operation.

Previous History.—The patient was a recently enlisted soldier and was not inoculated against typhoid. He had been quite well until the onset of pains in the legs. There was no history of previous illness except two attacks (at 14 and 16 years of age) suggestive of recurrent appendicitis. He had never been abroad. No family history of tubercle, syphilis, or blood disease could be obtained.

Subsequent Course.—The following day, November 24, the temperature remained up at 103° to 104°, the patient was lethargic and pale, with a soft and relatively slow pulse.

His abdomen was now distended, slightly tender all over, and still rather rigid. The tongue was dry with brown fur. A leucocyte count showed a leucopenia of 3,500. During the next two days he remained about the same except that his abdomen became tumid and less tender.

On November 27, owing to the above symptoms and signs, he was sent to the Infectious Diseases Hospital as probably "Enteric Fever" and came under my charge. His condition was as described, but the following additional facts were noted. The patient was very pale, with a rather "renal" appearance and complained of much headache. There was occasional muttering delirium with picking at the bed-clothes. The pulse was very soft and occasionally dicrotic. There was marked tenderness in the left hypochondrium and left lumbar regions of abdomen, and this tender area was dull on percussion. The spleen was not felt, but this dullness appeared splenic and reached down towards the umbilicus four fingers' breadth below the costal margin. The heart sounds were good and normal. There was diminished resonance over the lower lobe of left lung behind coming round to blend with the aforementioned dullness. No spots were seen. No enlarged glands were felt anywhere. The stools were fluid and yellow, with no slime, blood or curds. The urine was quite clear, no pus cells or casts were found and there was no bacilluria, but a trace of albumin was present. The serum gave no agglutination with the *Bacillus typhosus* or with either of the paratyphoid bacilli.

The diagnoses which so far had been suggested at various times were

acute peritonitis, recurrent appendicitis, and typhoid fever, the last being especially favoured. Acute lymphatic leucæmia was also suggested.

During the next six days the patient remained about the same, but the abdominal distension got much less, enabling the firm and slightly tender spleen to be felt easily.

On December 2 a leucopenia was still present—2,200 white cells per cubic millimetre—and the hæmoglobin was only fifty-two per cent of the normal. A blood culture made into a bile salt medium proved sterile and the agglutination reactions were again negative.

From December 2 to 5 the temperature came down in a "step ladder" manner and at the same time the patient rapidly improved; there was no distension of the abdomen and the spleen grew much smaller. Treatment had consisted in tepid sponging and the administration of a fluid diet, and constipation had been treated by enemata. The case was considered for the time being as one of typhoid fever. However, on two occasions both stools and urine failed to grow the typhoid bacillus or either of the paratyphoid organisms. The patient continued apyrexial for nine days, being quite bright and cheerful, and on December 31 commenced to take a little solid food. The temperature then quickly went up by steps, and this rise was associated with listlessness, headache, a dry furred tongue, a tumid abdomen, enlargement of the spleen, and some loose motions, and the pulse was soft and compressible. In other words, the whole condition was much like a relapse in typhoid fever, and it was feared that this had been caused by injudicious dieting. The patient, however, showed a marked pallor unlike a typhoid case, no spots were seen during the "relapse" and a second blood culture proved negative, and for the third time the serum failed to show agglutination with bacilli of the enteric group.

By December 30 the patient had steadily improved after seven days' normal temperature. He was not nearly so pale, was bright and cheerful, and with his thin skin and blue eyes had a look of the "sanguine" tuberculous type.

During this time the spleen had rapidly contracted until at this date it was no longer palpable.

On the evening of December 31 he again became listless and pale; the next day these features were very noticeable, and he again complained of pain in the toes and soles of the feet. Coincidently with this the temperature went up and the spleen again rapidly enlarged. The temperature soon came down only to rise again quickly on January 4. There was then a rapid increase in pallor and a still greater enlargement of the spleen. The abdomen was full and the liver was now made out to be slightly enlarged. The pulse was very soft but not dicrotic. There was diarrhœa and the stools were almost "typhoid" in character. Patient later complained of sore throat, bnt nothing was found and there were no enlarged glands in the neck. A blood examination at this time

showed 3,000 white cells and 3,600,000 red cells per cubic millimetre. A differential white count showed the following percentages: polymorphonuclears 80 per cent, lymphocytes 15 per cent, large mononuclears 5 per cent. No eosinophiles or nucleated red cells were seen and no parasites were found.

He was seen by several consultants and the diagnoses suggested were: A typhoid relapse, a splenic anæmia, and tuberculous peritonitis. The difficulties of the case at this time are shown by the possibilities also discussed, viz., Hodgkin's disease, Malta fever, kala-azar, congenital syphilis, and septicæmia. A blood culture made into broth was sterile and the agglutinations were again negative. The blood count was repeated a few days later, and again showed a leucopenia, and stool and urine cultures were again negative as regards bacilli of the typhoid group.

The temperature came down satisfactorily, and by the 20th the patient was better, although rather emaciated, with a weak pulse, and hæmic murmurs were heard at the base of the heart. The spleen also was smaller but still palpable and firm. Other than the spleen there were no glands to be felt anywhere. On January 21 he was given a mixture with arsenic and iron, and he had this for a little over a fortnight. On January 29 the temperature again began to go up, and the abdomen got markedly distended. This time there was free fluid in the flanks and lower part of the abdomen. The splenic dullness again increased and the pallor again became marked. There appeared to be a very indefinite mass felt on firm palpation above the umbilicus. Operation for tuberculous peritonitis was strongly advised by one of the consultant surgeons who saw him at this time and who thought that the above mass was matting of the omentum. Operation was, however, not performed, as the patient was getting rapidly very weak.

A blood count again showed marked leucopenia, the relative numbers of the white cells being normal except that only two eosinophiles were seen. The red corpuscles were down to 3,000,000 and the hæmoglobin down to thirty-five per cent, giving a colour index of about 0·5.

By February 8 the patient was very emaciated, with a gradually increasing jaundice of an obstructive kind, and there was some cutaneous mottling of a purpuric nature. Diagnoses which now suggested themselves were a splenic anæmia (especially Banti's disease), tuberculous peritonitis, or obscure malignant disease.

By February 13 the patient appeared to be dying. He was markedly jaundiced, very emaciated and weak, and the abdomen was distended. The general appearance was that of malignant disease in the abdomen with obstructive jaundice. The white-cell count had risen to 15,000, this probably being a rise associated with a dying condition, as death supervened thirty-six hours later, just twelve weeks from the apparent onset.

Diagnosis and Discussion.

The most noticeable features (considering the ultimate diagnosis) and the ones which led observers astray were as follows:—

(1) The acute onset with symptoms and signs suggestive of peritonitis.

(2) The subsequent remarkable resemblance of the case to typhoid fever. This was evidenced by the lethargy and quiet delirium, the soft, compressible and rather slow pulse, the "typhoid" tongue, the tumid abdomen and the enlarged spleen, the leucopenia, the supposed "relapses," and the diarrhœa with suggestive stools.

(3) The general resemblance to an acute infective fever.

(4) The relapsing course in which there were not only relapses in pyrexia but also a curious periodicity of symptoms and signs. At the onset of and during each pyrexial period there was rapid wasting and increasing pallor and a regular marked increase in the size of the spleen. This rapid alternate enlargement and contraction of the spleen seemed a noticeable feature of the case.

(5) The signs suggesting portal obstruction.

(6) And lastly and very important) the entire absence of enlarged external glands.

The above facts are some excuse for the failure to make an accurate diagnosis during life.

Hodgkin's disease was discussed in connexion with the enlargement of the spleen, but the above facts led us off the track. The patient was of the usual age for the disease, and it is more common in males than females.

The onset was remarkable. Cases have been described in which enlarged external glands were present for a long time or in which the process appeared "latent," and which then became suddenly acute in association with a bursting out into activity of the pathological processes in the glands. But when the deep glands only are involved the onset is usually insidious and the acute onset in such a case as this one seems very exceptional. Jaundice and ascites are commonly associated with the abdominal type of Hodgkin's disease. In at least seventy per cent of the cases enlargement of the superficial glands is the first thing noticed, and in the great majority the cervical glands are most affected. The entire absence of enlarged superficial glands in a case showing the relapsing fever of Pel and Ebstein is therefore most unusual. It has been suggested• that these pyrexial periods may be due to the presence of some secondary infection, and it should be noted, therefore, that besides the two blood cultures made into a bile salt medium, a blood culture was made into broth at the commencement of one of the periods and that all the cultures were found sterile.

As regards the blood cells, the leucopenia and the scarcity of eosinophiles are possibly unusual features. On the other hand, the very marked chlorotic anæmia is often seen, but the rapidity with which the

hæmoglobin (as estimated by Sahli's apparatus) reached as low as thirty-five per cent is unusual, and with other facts seems to be a sign of the very severe form taken by the disease in this case.

The resemblance to typhoid fever has already been mentioned. The onset, the absence of spots, the rapid general recovery as soon as the temperature was normal, and the completely negative findings in the laboratory were the chief points against this diagnosis in the early stages, while the later stages were quite unlike enteric fever.

In Banti's disease the probable source of the trouble is in the spleen itself, and the alterations in the size of the spleen suggested an affection in which the spleen displayed a leading part. Also the blood examination revealed a condition quite typical of this malady, namely, the secondary anæmia with a very low colour index and a leucopenia with no special change in the differential leucocyte count. Finally, the enlargement of the liver with the development of ascites and jaundice added decidedly to the resemblance of the case to this disease. In such a diagnosis, however, there were many obvious difficulties, namely, the onset, the rapid course and the general appearance, and the fever.

Tuberculous peritonitis was suggested by the tumid feel of the abdomen, there being present some generalized distension, and a soft elasticity on palpitation. Also, later there was ascites, and it was thought that rolled up omentum could be felt. An acute onset is not infrequent in this disease, and a high temperature is then common. The patient, too, appeared a tuberculous type.

Against this diagnosis were the general course, with relapses, the enlargement of the spleen and the absence of signs of tubercle elsewhere.

The leucopenia and the subsequent course were against the following earlier suggestions, viz., acute peritonitis, appendicitis, septico-pyæmia and lymphatic leucæmia.

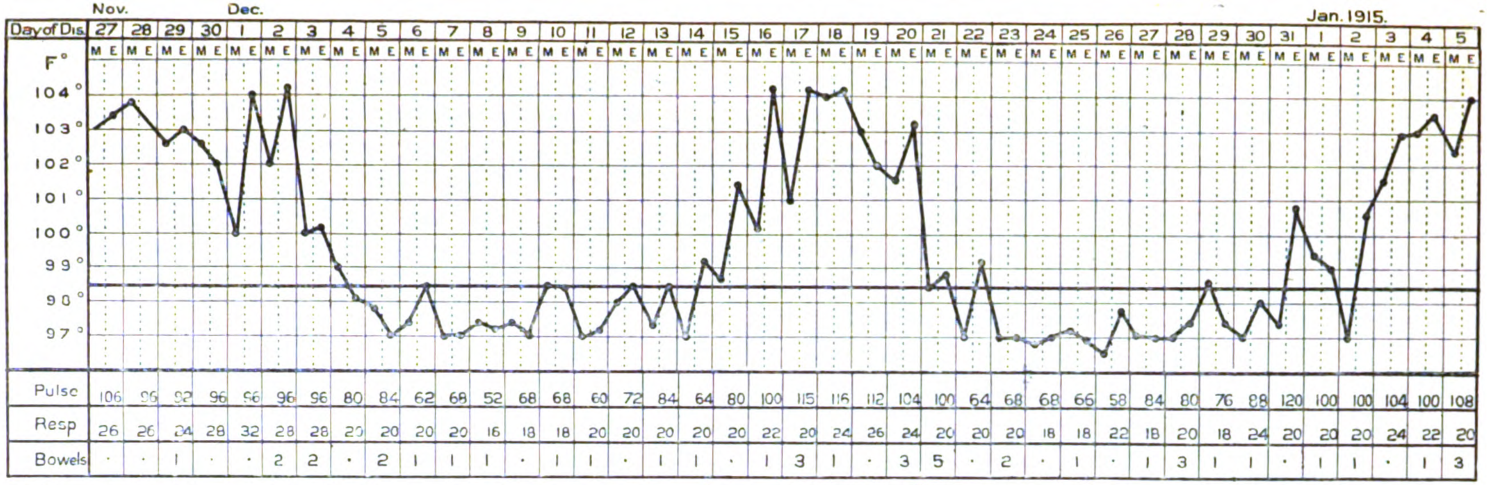
The predominant part apparently taken by the spleen, the resemblance to some infective fever, and the fact that the patient was a soldier suggested at one time, in the search for a diagnosis, such diseases as Malta fever, kala-azar, and relapsing fever, affections not usually thought of in dealing with Hodgkin's disease. Against these possibilities were the locality and previous history, besides the clinical and laboratory findings.

Post-mortem.

The body was very emaciated and deeply jaundiced.

Abdomen.—A large amount of free clear yellowish fluid was found. The omentum was normal except for a very diminished quantity of fat, and it showed no matting together. The rest of the peritoneum appeared normal, no tubercule or carcinomatosis being present.

The intestines and mesenteric glands appeared normal. The spleen was at least three times the normal size, of a dark slaty-blue colour and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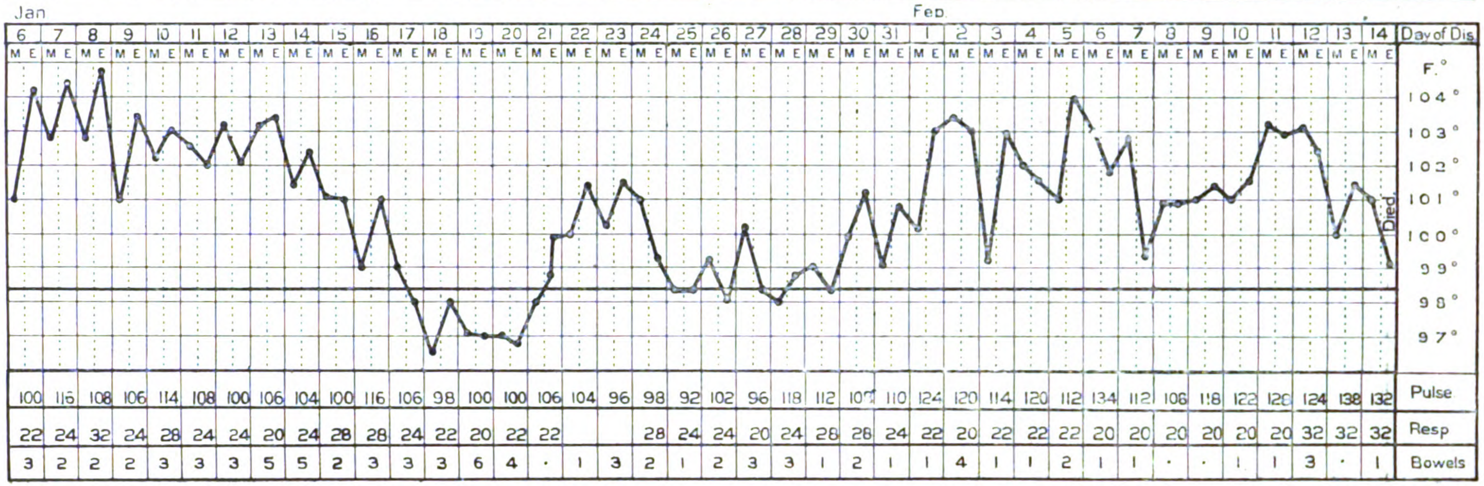
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decidedly firm and hard and not friable. On its surface were seen scattered yellowish-white spots about the size of a pin's head and slightly raised. There was no perisplenitis. On cutting the spleen open similar areas, in some cases larger, were seen scattered all about, and being yellow stained seemed like points of pus. They were found, however, to be fairly firm like little pieces of firm yellow fat. The structure in the hilum of the spleen appeared normal. The liver was a little enlarged but otherwise appeared normal. A gland in the portal fissure was enlarged and cut firm and hard, but it was quite discrete. It seemed to be pressing on the hepatic duct before this joined the cystic duct and the hepatic duct appeared dilated. The gall bladder was full, but the dilatation was not definitely more than might normally occur. It contained viscid mahogany-coloured fluid. The bile duct seemed a little dilated and appeared to have been pressed on by some enlarged glands behind the pancreas. It could, however, be easily separated from them and these glands were quite discrete. The kidneys were apparently normal and did not show any nodules, and both suprarenal capsules were normal to the naked eye. On attempting to remove the left kidney some very interesting abnormalities were found. On tracking down the left ureter it was found to enter a large irregularly lobulated hard mass—discovered to be retroperitoneal glands—extending from the level of the left renal artery down to the bifurcation of the aorta. This mass had prolongations downwards along the common iliac and iliac arteries of the left side and for a short distance along the common iliac on the right. The aorta and left ureter were enclosed in this mass, but did not appear to have been pressed on unduly. On dissection the glands were found to be regularly oval or rounded, smooth and discrete and apparently not obstructing ureter, arteries, or veins, or encroaching into surrounding structures. They were creamy-white in colour and cut firm, and some showed on the cut surface bulging areas between restraining connective tissue.

Nearly all showed a mottled appearance due to hæmorrhagic areas near the capsule. There was no growth at all through or outside the capsule and the glands appeared typically lymphadenomatous. The testes were normal. Some enlarged glands, one about the size of a walnut, were also found behind and above the neck of the pancreas, and were like those above described. The lungs, heart, and pleuræ showed no obvious abnormalities. The tracheal and bifurcation glands were decidedly enlarged, hard and discrete, cut firm and showed mottling, with areas of congestion, and were of a similar nature to those already described. They did not appear to have pressed on surrounding structures. Some old calcareous and caseous glands with sooty deposits were found adherent to bronchi at the root of the right lung and appeared to be old tuberculous glands. Some enlarged glands were found just behind and below the inner end of the clavicle on each side, one on the left being the size of a walnut. They also appeared lymphadenomatous like the

others. Otherwise the cervical glands were not enlarged. Portions of the retroperitoneal, portal, thoracic and subclavicular glands and spleen were kept for histological examination. They were found to show the typical appearance of Hodgkin's disease. These glands showed proliferation of the endothelial cells and of the reticular tissue, in the meshes of which numbers of moderately large lymphoid cells and the characteristic giant cells or "lymphadenoma cells" were evident. These were nearly all of the mononuclear type, the big nuclei showing pale blue indefinite staining with deeply stained dots scattered about (nucleoli and chromatin granules). No giant cells with the "horse-shoe" arrangement of nuclei were seen. The proliferation of the connective tissue did not seem far advanced in any of the glands examined, and this fact, in conjunction with the presence of hæmorrhagic areas, suggested (apart from the clinical evidence) that the disease was rapid and acute in this case, and not as is usual, slow with progressive and finally marked increase in the connective tissue.

One can say that the mass in the abdomen did not appear old, and that the case was probably not one of the "latent" variety with a subsequent bursting out into activity.

The indefinite mass felt during life and supposed at one time to be matted omentum was probably this mass of retroperitoneal glands, and this mass by pressure on nerves possibly accounted for the pains down the limbs and in the feet and toes, for which the patient went sick and which he again had while in hospital. Such symptoms do not appear uncommon in cases of the abdominal variety. That a case of Hodgkin's disease should first come under observation for this complaint and be diagnosed "frost bite" must certainly be uncommon. The associated circumstances and the prevalence of "trench foot" amongst the soldiers at the time accounted for his being sent down to hospital with this diagnosis.

It was interesting to find that the supposition of an enlarged gland in the portal fissure was confirmed, but more interesting to find that this enlargement was due to lymphadenoma. Almost all the symptoms and signs were now explained except the acute onset, the toxic symptoms, and the fever.

The whole aspect of the case seems to support the view that Hodgkin's disease is due to some infective organism, which in this case was particularly virulent, and which had its chief habitat in the retroperitoneal glands and spleen.

THE MOBILIZATION AND EARLY CAREER OF NO. 3 GENERAL HOSPITAL, BRITISH EXPEDITIONARY FORCE.

By Colonel S. F. CLARK, A.M.S.

In the office of the Deputy Director Medical Service, Western Command, at Chester was a secret pad marked "Mobilization No. 3 General Hospital." It was a good pad, complete to the smallest detail, and much time, trouble, and correspondence had gone to the making of it. Those concerned used to study it from a sense of duty, but with only an academic interest, as a thing that might possibly be of use to their successors on some far-off day, but was of no particular concern to themselves. At the beginning of August, 1914, however, this pad suddenly assumed an importance that had seemed incredible, and it was conned over line by line with a new and personal feeling by those for whom it had been compiled. From a collection of dry and tedious documents it flashed at a bound into a living, palpitating volume of absorbing interest.

One memorable evening a buff slip containing the single word "mobilize," duly authenticated, was handed to the officer commanding this phantom unit, which so far existed only between the covers of the pad, but this word was the spark that started the materialization of No 3 General Hospital out of nothing, as it were. To watch the development of this process promised to be a matter of the deepest interest. At the word the dormant atoms scattered over the Kingdom that were to form the hospital, sprang to life, and next day onwards the men, women, horses, and stores, that were detailed in the pad began to converge from all over the country, from near and from far, to the little Lancashire village that was to witness the formation of the new unit. By the evening of the first day of mobilization the five regular officers and the serving soldiers, practically all from the Western Command, and the horses—provided locally—had arrived. The animals were stabled, and the officers and men took over the building which had been previously chosen for the purpose and occupied it. It was a working men's Institute with only the floors to sleep on.

The first shock was to find that the rations which had been wired for from Chester as per pad, were not forthcoming, and the commanding officer had to render himself liable for a large sum of money to feed his officers, men, and horses during the period of mobilization. The pad was not to blame for this, as the compiler of it had not been informed that the method of obtaining food for all had been changed.

Every day added to the strength of the unit. Regular Royal Army Medical Corps reservists, "infantry" reservists, and Royal Garrison Artillery bâtmen arrived in rapid succession, while temporary lieutenants came singly and in batches. The matron and nursing sisters were reported to have reached the nearest large town and to be at the hotels

that had been ear-marked for them. An officer was sent over and found them to be all present and correct. An unexpected arrival was a chaplain, whose bâtman came armed with carbine, sword and ammunition. All the time telegrams from the War Office, Record Office, Deputy Director Medical Service, etc., were constantly being received.

The medical, laboratory, and X-ray stores in 146 cases which the quartermaster had dispatched from Chester before his departure for Lancashire came to hand with celerity, and no time was lost in beginning the drawing of the Ordnance equipment. This was all ready in a large double-storeyed shed close to which a railway line had been brought, and early on the second morning a start was made in loading up the trucks by the soldiers who had arrived. The personnel now made its first acquaintance with a bulky and heavy equipment whose handling on many subsequent occasions caused much sweat to flow. At first, progress in this unaccustomed work was slow, but then all idlers of every rank were rounded up from the Institute, officers and N.C.O.'s were flung into the breach with coats off, all fresh arrivals were hurried up to the scene, and a senior officer put in charge, so that the place soon hummed like a hive of bees, and the goods came out of the shed in a flood. With reinforcements constantly arriving the men worked hard and well, and the shed was cleared and the trucks loaded in excellent time. So closely were they packed that five of the trucks allowed by the pad were not needed.

On August 5 the hospital existed only on paper; five days later it stood ready to move off, complete in officers, sisters, men and horses—all fully equipped—and with all its tons of stores loaded up in the railway trucks. Except for the food hitch, the pad had not failed in a single detail. As the temporary lieutenants had not even expressed their desire to serve when mobilization was ordered, as many of the reserve sisters were at their homes, and as the great bulk of the N.C.O.'s and men had to come back from civil life, this seemed to be quite a good piece of work.

The departure of the unit was postponed for three days, which caused some disappointment, but the extra time was profitably employed in polishing up details. The local people were most kind in entertaining all ranks at their homes and by concerts, etc., and in looking after the nursing sisters who joined up on the last afternoon. On the Sunday the unit marched to the Parish Church, when the rector gave a most inspiriting sermon, and "Onward, Christian Soldiers" was sung with a swing and a verve unknown in peace time.

On the last morning, August 13, all ranks paraded for the issue of brassards and clasp knives, after which the commanding officer addressed his fully-equipped command, and told it that it must play its part well in the great drama that was being enacted on the stage of Europe. Eight months afterwards, in France, in bidding farewell to his unit, the

commanding officer recalled these words to his men, and said that the hospital could look back with pride upon what it had done since that sunny morning in England.

In the evening the unit departed in two trains for an unknown destination, amid the cheers and good wishes of the kindly villagers.

Early on the morning of the 14th the trains arrived at Southampton Docks prompt to the minute recorded in the pad, and were rapidly cleared of their loads. The only weak point of the preparations now showed itself, for the officers and sisters had been slumped together as "officers" in the train-table in the pad, and the embarkation staff was aghast when it found forty-three women to be provided for, as the ship detailed was impossible for them. However, certain good Samaritans took charge of the sisters, and they were eventually consigned to Havre in a mail boat, and so scored over the officers, most of whom had only deck accommodation through a wet and dismal night.

The ship "Seven Seas" was waiting for the hospital and a few details of other corps, so the unit conveyed its ninety-five tons of stores across the shed and loaded them into the vessel. She was not designed for passenger traffic, but as she is now at the bottom of one of the seas from which she took her name, *de mortuis*, etc., is her due. At 1 a.m., on the 14th, she cast off her hawsers, and there were few on board who did not wonder what the future had in store for them, now that they were really leaving England to take their allotted place in the greatest war of history. Later on, as our armies grew in size, they all remembered with pride that they were of the original Expeditionary Force that went so swiftly and so quietly over the sea.

The voyage across was wet and miserable; in the morning the tiny saloon was almost impassable on account of the officers who were lying asleep all over the floor in the strangest attitudes, having been driven in for shelter from the inhospitable deck. Two destroyers were passed, policing the seas, and late in the afternoon the ship entered the Seine and had a triumphant journey up it as long as daylight lasted. The scenery was beautiful and the inhabitants of every township, hamlet, and cottage on the banks turned out to see "les anglais." They welcomed the vessel with the utmost heartiness, flags were flying everywhere, the women and girls waved handkerchiefs, while cheers and crys of "Vive l'angleterre" came constantly over the water. The ladies of one place came out in boats and presented a huge bouquet bound and bedecked with the red, white and blue ribbons which are the colours of both France and England. For a long time the troops were quiet, but later on the cheers were returned, and "Vive la France" was shouted with vigour and enthusiasm, interspersed with "Tipperary" and inquiries as to the downheartedness of those on board. About 11 p.m. the ship reached Rouen, her destination, and tied up at the quay amid pouring rain. Centuries must have passed since British troops went up the Seine, and

they were then the enemies of France and not her allies against a common foe.

Next morning the unit was ordered to establish itself in the building and grounds of the Maison de Repos, in the Bois de Guillaume (the Conqueror), about three miles from the river, and again handled all its equipment—out of the ship into motor lorries and out of them again. Patients could have been taken that evening if necessary, but there was no immediate pressure for beds and cases were not received till the 20th. A large number of marquees were pitched, and numerous alterations made in the interior of the building. The nursing sisters reappeared, by rail from Havre, and were accommodated in a convent close by which had certain disabilities both animate and inanimate.

It was thought that a General Hospital sat tight once it was started, so the unit laid itself out to spend the winter in Rouen and much work of a permanent nature was put in hand by the Royal Engineers. But the Director Medical Service visited the place one day, seemed a bit worried, said everything was very nice but how long would it take to pack up and move off? It was confessed that this question had not been considered, but plans for a hurried departure were at once taken in hand as a plain hint was given that this was more than a possibility. It was soon evident that all was not well at the Front, so when midnight orders were received to clear out the patients and to re-embark everything that could be saved, the hospital was a bit shocked but not altogether surprised. The story of this retreat from Rouen has been written as a separate article, so it must suffice now to say that by prolonged working under great pressure in the sultry heat, the patients were cleared to a hospital ship, and the equipment (no longer nicely baled) was once more put into motor lorries, taken to the riverside, and loaded into a ship, the "Lord Charlemont." All the stretchers were kept on the over-loaded hospital ship as beds, but everything else was got away except 400 screwed up bedside tables and the Thresh disinfector. The last named started off in good style at the tail of a slow-moving lorry, but it was not built to travel far, foundered about half a mile from the ship, and is said to have remained for days an obstruction to the traffic of the busiest street in Rouen. The hospital rear guard, trundling down the diet carts, slop receptacles, and wheels for the wheeled stretchers, passed it at 2 a.m. on S ptember 1. It was then a hopeless wreck, abandoned to its fate, with wheels buckled to a figure of eight, and gendarmes engaged in fastening a red light to it.

The sisters disappeared again, going off by rail this time, and succeeded in losing their heavy baggage for some weeks. The voyage to St. Nazaire, the new British base, at the mouth of the Loire, was a welcome rest to all ranks, for the physical exertion which had been undergone was tremendous and the mental strain of the fight against time to get the hospital away intact, tried the senior officers greatly. The procession of transports was not cheered this time for the people knew that the allies

were retreating, and it was a subdued, silent, and apparently depopulated countryside that wistfully watched the British ships hurrying down the Seine.

All was bustle and animation at St. Nazaire and No. 3 was started to work at once. It was the first General Hospital to arrive with its personnel and equipment in the same ship, and its luck was still in, for it was the only hospital to have a building assigned to it—this time a "College de Garçons." The ship's derricks began to work at 6 a.m. and as the need for immediate hospital accommodation was very great, and as the school was not available at once, some marquees and things absolutely essential were sent up to a field adjoining it, where a temporary hospital was hurriedly got ready. Once more the weary unloading from the ship, loading up vehicles, and unloading them a mile away, began. Owing to bad work by the French stevedores in the holds, every now and again a slingful of bedsteads became loose and they either fell into the water or crashed on to the stone quay and were battered into uselessness. Tents were also occasionally precipated into the sea and were fished out with difficulty. There were no motor lorries here, only half a dozen carts each drawn by one more or less indifferent horse, so the second in command who was sent up to form the temporary hospital did well to take cases into the marquees the same night.

In a day or two the building became available, and after unscrewing the forms and desks which were fastened to the floor of nearly every room, the hospital fell back into it from the field, which was handed over to a stationary hospital. Owing to the lack of efficient transport and to interruptions to the unloading of the ship, it was several days before all the equipment was got up to the college. As soon as the building was available, the nursing sisters, who had arrived by train long before the officers and men in the "Lord Charlemont," and who were temporarily housed in the neighbouring watering place of Pornichet, where they wisely spent most of their time in the sea, were sent for in parties as fast as they could be accommodated, and were soon hard at work getting beds made and preparing for casualties.

After overcoming the passive resistance of the bewildered Director of the college who brought up the Mayor and the French Commandant to his assistance, marquees for patients were pitched in the school grounds. Tents for the personnel of all grades were put up in a field across the road, no questions being asked of anybody as there was no other solution of the matter. The owner of the ground watched the proceedings in silence and was amicably squared later on.

As No. 3 was the first hospital to get to work, and as casulties from the heavy fighting of the end of August and of September came pouring in, life was very strenuous indeed, and the unit became practically a clearing station for the hospital ships.

The pressure for beds was so great that every case that could possibly

be moved had to be sent on. Terrible shell wounds came in, dead bodies were sent up for burial from the ambulance trains, sick and wounded German prisoners of all ranks were admitted in large numbers, enteric cases arrived, and tetanus became a nightmare. For several weeks the unit was constantly taking in and sending out—sometimes the two proceedings were carried on simultaneously—to hospital ships, base depots, and convalescent camp. A certain number of slight cases succeeded in "stowing away" in the ships, until efficient steps were taken to stop this movement, whose existence had not been suspected at first. Altogether the personnel of No. 3 will never forget the sustained pressure under which it worked during its first few weeks at St. Nazaire.

After the German advance had been stopped, the Line of Communications gradually reverted to the North and St. Nazaire was abandoned by the British troops. The staff, the base depots, the other hospitals and the Convalescent Camp departed, and it seems to be worthy of record that at one time the Commandant of the British Base at St. Nazaire was a Royal Army Medical Corps officer, for the Officer Commandant of No. 3 was formally appointed to that position by the departing Commandant, although some combatant officers (below field rank) were still left.

Finally No. 3 was left by itself with over 400 patients, and minus several officers, its matron, twenty-seven sisters and some rank and file, all of whom had been sent to other units. Orders were received for the hospital to go to Rouen, after clearing itself of its patients, for which purpose the "Asturias" was sent down, but bad weather forced her to retreat from the harbour mouth to the shelter of Belleisle. When she *did* get in the first walking party of patients was at the quay as soon as she was. The evacuation of the sitting and lying down cases was a memorable sight, for local transport only was available, and a collection of vehicles less suited for the conveyance of stretchers never was seen—cabs, governess carts, chars-à-bancs, etc. However, stretchers were lashed "athwart-ships," the wheeled stretchers were used to their fullest extent, walking parties were made as strong as possible, and the hospital was cleared very quickly.

Next day began once more the handling of all the equipment, and loading it into a train, and about November 19 (no diary available) the personnel marched through the town to the station after dark, and entrained, the bugler playing his best and the inhabitants giving a cordial farewell to the last of their thousands of visitors. The handful of sisters left accompanied the unit this time, but were so unused to the experience that they nearly lost the train. At 7.30 p.m. the journey northwards began, and early on the morning of the 21st the train drew up in the goods yard of one of the Rouen stations. It was freezing and bitterly cold, and when the commanding officer was taken to a heath-covered moor, white with snow, and swept by a piercingly cold wind, and was directed to

pitch his hospital there, he returned and told his officer that No. 3's luck was out at last. But he was wrong, for after the personnel (less the sisters in billets) had moved up to its allotted place, and before the whole of the store had been removed from the train, instructions were received to stand fast and await orders to go to a brand new place that was more or less a secret. The spirits of all ranks rose with a bound, and the advisibility of burning a really big candle before the shrine of St. Anthony of Padua in the Cathedral, so that the new place might be a good one, was seriously considered. Then a rumour went round that the unit was destined for Le Treport, and the other hospitals were thought to look upon No. 3 with jaundiced and jealous eyes.

On November 29 an advance party consisting of the commanding officer, adjutant, quarter-master, and interpreter, with twenty-seven other ranks, started by rail, spent the night at Abancourt and arrived at Le Treport on the 30th. They were the first British troops that had been seen there, and the station and its approaches were crowded by townspeople, who evinced the utmost interest in the newcomers and clapped their hands vigorously when the party marched off in fours. The route was through the town and up a steep road to the Trianon, the finest hotel in France, which was to be the new home of the hospital. It stood on the edge of the cliff some five hundred feet above the sea, was swept by invigorating breezes, offered magnificent views, and was visible for miles from both land and sea. The colossal proportions of the hotel, its huge entrance hall, spacious corridors and general completeness made the buildings which the unit had previously occupied seem very small indeed. It was so large that it took under its roof over 600 beds, all the officers and sisters (full strength) and one half of the other ranks—the remainder fitting into the garage.

The party set to work to store the furniture in some basement rooms—a laborious task as there were four other storeys and no available lift.

The main body arrived in a few days, all grades were brought up to strength, and the return of the matron gave universal satisfaction. The equipment was distributed over the hotel, making the fifteenth time in four months that each article of the ninety-five tons of stores had been moved by the personnel, but it now seems to have found rest.

Except for an Army Service Corps supply officer, No. 3 had Le Treport all to itself for several months, and had to make all its own arrangements of every kind, even to providing funeral parties for the dead. A most happy Christmas and New Year were spent, numerous distinguished visitors were received, convoys of sick and wounded came and went, everybody was proud of their splendid building, and it was generally felt that the hospital had undoubtedly found itself. It still flourishes at the Trianon; very few of those who embarked with it are now on its books, but all cherish the memory of No. 3.

The burial of the first British soldier (an R.C.) who died at

Le Treport, merits a description, as it shows how the local French people evinced their appreciation of their allies from over the Channel. The tricolour on the flagstaff of the local *mairie* hung all day at the half mast, and before the hour fixed for the funeral all the local dignitaries mustered at the hospital, including the British Consul, the Mayor, Corporation and leading citizens, the Chief of Police, French Commandant and officers, Red Cross ladies, wounded soldiers from the French Hospital, including Zouaves and men from Algeria, Customs officials with rifles and fixed bayonets, a detachment of armed French infantry, a civilian band which headed the cortège and played appropriate music down the winding road to the cemetery, and large numbers of the general public. The town also kindly provided a hearse and tendered a magnificent wreath of bead flowers, as is the custom in France. No. 3 sent an officer and thirteen other ranks, while the commanding officer and the Church of England chaplain also followed. The local abbé, with choir boys and surpliced attendants also walked all the way in the long procession, and he conducted the service according to the rights of the dead soldier's faith. The coffin was covered with a purple cloth and a Union Jack which ordinarily flew in front of the building. At the graveside the mayor delivered an address eulogizing the British nation, and the band played the "Marseillaise" and "The King." The hospital bugler then sounded the last post over the grave, and the great concourse slowly dispersed.

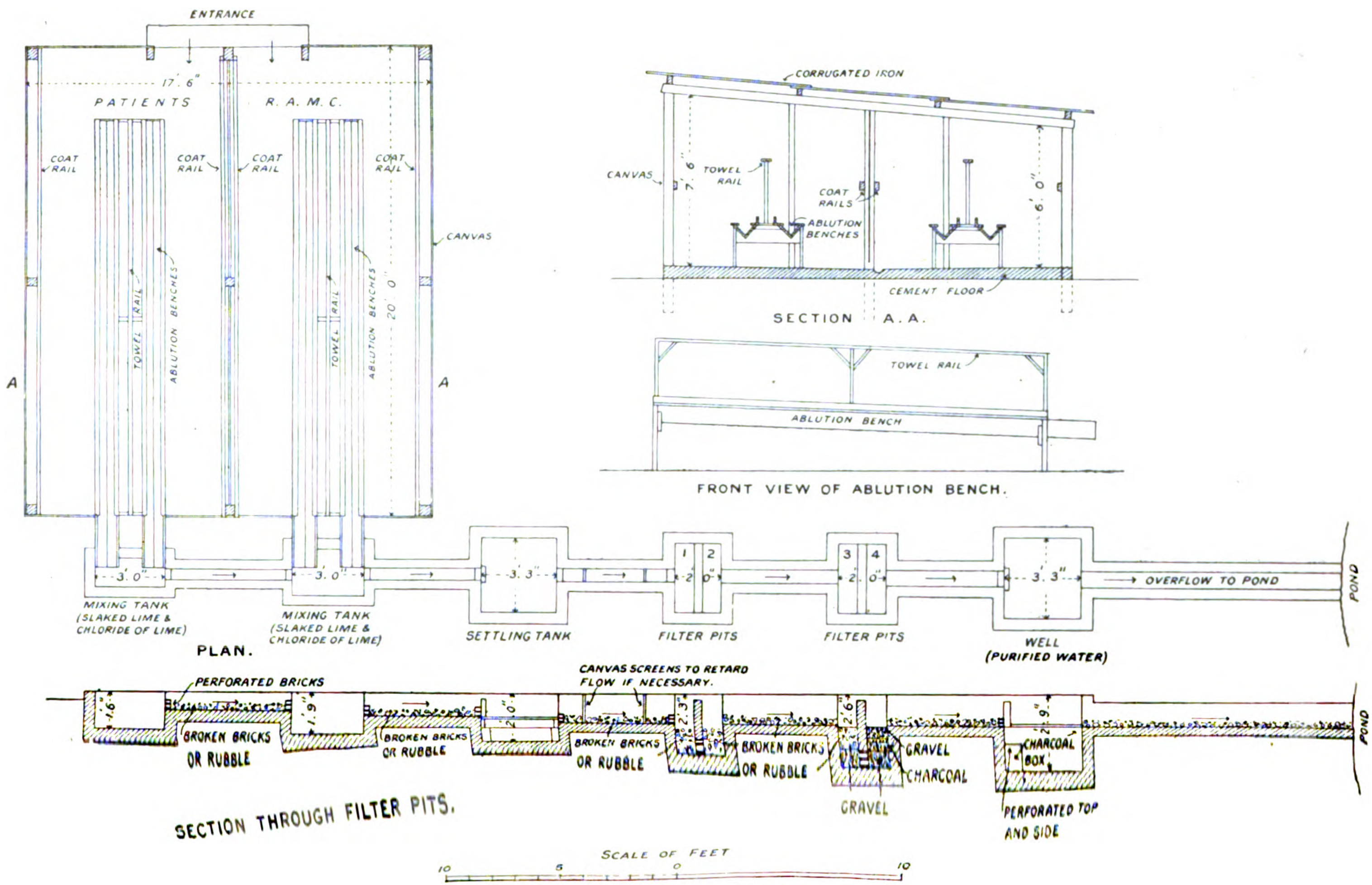
ABLUTION WATER PURIFICATION.

By Lieutenant-Colonel A. D. SHARP.
Royal Army Medical Corps (Territorial Force).

The water supply in France and Flanders is so limited in many areas that during the dry months the Military Authorities had to face the possibility of a water famine both for men and horses. Only the dirtier pond water was allowed for ablution and this in very limited amount. It therefore became necessary to conserve what supply there was and to use it over and over again for ablution.

To precipitate the soap and purify the ablution water I introduced a simple system which has been working for about six months at the Divisional Rest Camp, and which has been so successful and so constant in its good results that I think the method is worth describing.

The Ablution Shelter shown in the plan is very practical, serves its purpose admirably, and stands a lot of hard wear and tear and is sufficient for a personnel of from four hundred to five hundred. The ablution benches are arranged in pairs close together as this is the most economical in space. Pieces of soap are prevented from falling into the mixing-pit by a piece of perforated tin fixed about one foot from end of trough.



Ablution shelter, etc.

A towel-rail is arranged between the benches, and a coat-rail along the sides of the shelter.

After ablution the basin is emptied into the trough which has a gradual fall towards the discharge end. Two mixing-pits are shown in the diagram, one for each pair of benches. The dirty water falls into the pits where it mixes with slaked lime and chloride of lime. One large teacupful of the former in paste, and half the same amount of chloride of lime in paste, is added to each mixing-pit every morning. The same amount of slaked lime is added during the forenoon and again in the afternoon if ablution is going on. The Orderly in charge stirs the water in the mixing-pits occasionally. The water flows into the settling-tank, and thence through the filtration pits into the well-pit where it is withdrawn for re-ablution as a clear pure water. Between the settling-tank and the filter pits two frames with canvas centres are placed, these act as traps to retard the flow when necessary. There are four filter pits arranged in pairs: 1 and 2 are placed close together and only communicate through a tunnel in the deepest part so that the water has a down and up flow; 3 and 4 are similarly arranged. Filter pits 1 and 2 are three-parts filled with broken bricks or gravel; 3 and 4 are three-parts filled with gravel and charcoal. A charcoal box with perforated lid and side lies in the bottom of the well. The mixing-pits and settling-tank are cleaned out once a week, the filter beds once a fortnight.

For winter use all the pits should be bricked and cemented. In summer when bricks, etc., are not necessary, the filter pits 1 and 2 should be separated by not less than two feet of earth, the only communication being by a broken-brick tunnel in the deepest part; 3 and 4 should be similarly arranged.

This system requires no technical knowledge other than can be found amongst the personnel of a unit. The plan shown has been prepared by a Private of this unit, and the ablution shelter built and the system bricked and cemented by the N.C.O's. and men of this ambulance.

I strongly recommend this as a very practical, reliable, simple method of purifying ablution water; and, with the bath-house and ablution shelter close together, as is arranged in this unit, the one system does for both.

The bath-house water requires the same amount of lime, and should have its own mixing-pit and settling-tank, and then be linked up with the settling-tank from the ablution bench.

NOTE ON STERILIZATION BY HEATED OIL.

By Capt. H. S. Blackmore, R.A.M.C., and Grace Briscoe, M.B., B.S.
Working under the Medical Research Committee at University College Hospital.

The sterilization of syringes by oil heated to a temperature of 140° F. has been recommended as a general method by Sir A. E. Wright,[1] on the ground that oil heated to this temperature "will sterilize instantaneously everything with which it comes in contact," while the temperature is not high enough to melt the solder of the syringe. Dreyer and Walker[2] have however, pointed out that since "the heating of spores in glycerine or oil has no greater disinfecting action than exposure to dry air at the same temperature for the same length of time" . . . therefore, "if resistant spores are present, sterilization of instruments cannot be ensured with certainty in a brief period."

The following observations show that even non-sporing organisms are not destroyed instantaneously by oil heated to a temperature of 140° F.

In the course of a series of control blood cultures from normal individuals, an appreciable number were found to be contaminated. By a process of exclusion the syringe was suspected as the source of infection. The method of sterilization which had been employed was as follows: Three to six barrelfuls of oil heated to 140° F. were drawn into the syringe, taking care that the oil reached every part of the interior, the needle was then fitted on and oil drawn up twice through the needle.

The following experiments were made:—

An emulsion containing cocci and bacilli from a contaminated blood culture, was drawn up into the syringe and expelled. Six syringes of oil at 140° F. were then drawn up in succession. In order to preclude the possibility of either extraneous organisms falling on the needle, or oil from the exterior of the syringe running on to it during cooling, the needle was simultaneously sterilized in boiling water, and the needle arm of the syringe was plunged into the same water the moment before the needle was attached. Broth was then drawn into the syringe, expelled into a sterilized test-tube and incubated. Both cocci and bacilli were recovered. The experiment was repeated with organisms which had been previously identified.

The *Bacillus coli* was recovered after two syringes of oil at 140° F., but was killed by four syringes.

Streptococcus fæcalis was recovered after four syringes of oil at 140° F., but was killed by six syringes.

Staphylococcus aureus was recovered after six syringes of oil at 140° F.

The experiment was repeated with the needle fitted to the syringe,

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[1] "Technique of the Teat and Capillary Tube," p. 194.

[2] *Journ. Path.* 1912. xvii, p. 142.

the heated oil being drawn up through the needle. Again *S. fæcalis* was recovered after four syringes of oil, but *S. aureus* was only recovered after two syringes, and was killed by four syringes.

It is therefore clear that this rapid method of sterilization is not effective even in the case of non-sporing organisms.

Further experiments were performed as follows :—

A small portion of growth from an agar slope was picked up on a platinum loop. The wire was plunged into the oil bath at 140° F., and held there for a definite period. A broth tube was then inoculated.

B. coli was recovered after a period of ten seconds, but was killed by twenty seconds in the oil. *Streptococcus fæcalis* was recovered after thirty seconds, on two occasions after forty seconds. *Staphylococcus aureus* was killed by five seconds in the oil.

We have found the following to be a convenient and reliable method of sterilizing syringes for blood cultures. An all-glass syringe is fitted together with needle attached. Alcohol is drawn through to ensure absence of moisture. The piston is withdrawn a quarter of an inch to prevent sticking after the heat. It is then placed in a large test-tube with a wool-pad at the bottom and plugged. The whole is put in the hot air sterilizer, which is heated to 160° F. for fifteen minutes. The air is then allowed to cool gradually. The syringes do not crack, and are ready for use without further handling, and need not be exposed to the air until the moment of employment.

This method of hot air sterilization has been tested by contaminating the syringes with the same organisms as were employed in the foregoing experiments. The non-sporing organisms were killed by an exposure to 140° F. for fifteen minutes. The spores of *Bacillus subtilis* were not destroyed by the same exposure, but they were killed by a temperature of 160° F. for a similar period.

Reviews.

SERUMS, VACCINES AND TOXINS (MODERN METHODS OF TREATMENT SERIES). (Bosanquet and Eyre). Third Edition. Cassell and Co. March, 1916. Pp. viii and 436. Price 9s. net.

The increase in our knowledge of serums, vaccines and toxins during the last six years finds adequate recognition in this book, which will be of great value to anyone who desires a sound and fairly detailed account of this subject. The size, general arrangement and style of the book render it particularly agreeable to a reader whose time is limited, and the clearness with which the various theories are set forth as well as the good index is to be very highly commended.

In this ever growing field of knowledge where personal opinions may differ so widely, and sometimes so fiercely, such a plain unbiassed account is welcome, especially since the importance given to the fundamental facts and the more elementary deductions therefrom should help in the formation of that cool and critical judgment so necessary in dealing with the more difficult offshoots. Information gained during the present War finds here a quite sufficient expression, and those points on which at present there is imperfect agreement are neither omitted nor pushed into undue prominence.

The complement-fixation section is particularly good and includes an account of the extension of this process of investigation into other diseases than syphilis. There is a good though short account of chemotherapy. The subject of tuberculosis receives a considerable amount of attention and is marked by a studied fairness, thus for example, an extensive list of the various tuberculins on the market is balanced by a very cautious if not pessimistic appreciation of their value in pulmonary tuberculosis.

The book should well fulfill the function of an introductory handbook to the subject and be of great service. F. W. W. G.

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Original Communications.

THE MORBID ANATOMY OF WOUNDS OF THE THORAX.

BY TEMPORARY CAPTAIN HERBERT HENRY, M.D.
Royal Army Medical Corps.
AND
TEMPORARY MAJOR T. R. ELLIOTT, F.R.S., F.R.C.P.
Royal Army Medical Corps.

IN civilian practice a wound of the chest is a condition seldom met with, but in military hospitals at the present time it assumes a position of considerable importance. Those who have occasion to treat such cases will realize how numerous are the difficulties that present themselves both in diagnosis and in treatment, for penetrating injuries of the chest have features that are novel both to the clinician and to the pathologist who have no other experience than that of ordinary peace-time hospital practice to guide them.

A detailed investigation of wounds of the thorax was undertaken by us at the instigation of Colonel Sir John Rose Bradford, Consulting Physician to the British Expeditionary Force in France, and the present paper summarizes the pathological observations made since November, 1914. During that period we have been able to collect records of 100 fatal cases of wounds of the chest.

The two large hospitals nearest to the railway station received a considerable number of particularly serious cases, and it was from these two hospitals that practically all our material for autopsy has

been derived. The journey down by ambulance train from the medical units near the Front took from eight to twelve hours. It was very rarely that we saw a chest wound earlier than twenty-four hours after the injury had been received. A considerable number arrived on the second or third day, though these were generally light cases which survived. The earliest deaths of which we had autopsies were on the third day and the majority were in the second or third weeks.

From these preliminary statements it will be clear that the description of thoracic injuries detailed in this paper represents only certain lesions and their fatality at a particular level on the lines of communications, or, in other words, that it gives the pathological changes seen when death occurs either late in the first week or subsequently during the course of the first month after the wound.

The mortality of chest wounds on the field or in the front medical units during the first or second day is high. Of the gross anatomical lesions associated with these severe wounds we have no evidence to record in this paper. Nor can we speak of the late results of a chest wound, of which the facts can only be collected in the home hospitals of England in the rare event of a death there. Our observations, therefore, deal only with such types of thoracic injury as can be seen in cases that survive long enough to reach the base and die there. The earliest and latest results of chest injury are virtually excluded from our experience.

For convenience of description we have divided the present paper into the following sections :—

(I) A classification of wounds of the thorax.

(II) The cause of death in wounds of the thorax.

(III) The appearance and disposition of the thoracic viscera after the establishment of a hæmothorax or of a pneumohæmothorax.

(IV) The injury to the chest wall.

(V) The damage to the lung.

(VI) The origin of the bleeding in hæmothorax.

I.—A Classification of Wounds of the Thorax.

The simplest classification of wounds of the chest is one founded on an anatomical basis. Broadly speaking, thoracic injuries may be divided into two main groups.

Group A.—Non-penetrating Wounds.

This group includes cases in which there is damage to the thoracic wall but no injury to the subjacent serous cavities or their contents. The term serous cavities would include the pleura, the pericardium, the peritoneum and the spinal meninges. Injuries which implicate muscle, cartilage, bone and the accompanying vessels with no deeper penetration of the chest wall, present rather fewer clinical complications than are associated with similar wounds in other parts of the body, and in no case in our experience have they been the direct cause of death. The possibility that intra-pleural bleeding might result from lung contusion accompanying a non-penetrating wound of the chest wall, that is, a wound in which there is no pleural damage, has been steadily kept in mind throughout, but no case has been observed at autopsy.

Group B.—Penetrating Wounds.

Into this group come all those cases in which there exists damage to the thoracic parietes together with damage to a serous membrane and its contents. The group includes all injuries of the chest wall which involve lesions of :—

(1) The thoracic contents, that is, the pericardium and the heart, or the pleura and the lungs.

(2) The vertebral column, the spinal meninges and the spinal cord.

(3) The peritoneum and the abdominal viscera.

The relative incidence of these injuries in our series of fatal cases is dealt with in the following section.

II.—The Cause of Death in Wounds of the Thorax.

A clearer picture of the exact nature and severity of the cases which have come to autopsy may be obtained if we give a brief summary of what we have found to be the cause of death in our series of 100 consecutive cases.

In 6 out of the 100 cases there was injury only of the thoracic vertebræ and spinal cord with no other damage to the chest wall or to underlying structures. The remaining 94 showed damage to the chest wall with or without damage to the thoracic and abdominal contents. These 94 cases can be further subdivided into two main groups, viz., 78 with hæmothorax and 16 without hæmothorax.

In only 8 of these 78 cases with hæmothorax has death been

apparently due to simple bleeding, and even this would be too generous an estimate, for the number includes 4 cases in which sepsis may very well have existed, but in regard to the presence or absence of which we have no definite proof in our post-mortem books. The remaining 70 cases of hæmothorax are all cases which showed complications, either, (1) injury to some viscus in addition to lung damage, or, (2) sepsis. Those complicated by additional visceral injury number 26, the remaining 44 being complicated by sepsis in the hæmothorax fluid. Also, out of the 26 cases with additional visceral injury, 16 had an infected hæmothorax fluid; and if these 16 be transferred to the septic group, we get a sum total of 60 out of 78 cases of hæmothorax in which death is directly attributable to or largely decided by infection of the hæmothorax.

The appended Table A presents these facts at a glance.

TABLE A.

FATAL THORACIC WOUNDS.
100

Injury to thoracic wall with or without injury to the lung 94		Injury to vertebræ and spinal cord only 6
With hæmothorax 78		Without hæmothorax 16 (see Table B.).
Complicated 70		Simple and doubtful 8
Infected hæmothorax fluid 44	Infected hæmothorax fluid plus additional visceral injury 16	Additional visceral injury 10

Septic hæmothorax
60

Another determining factor in the fatal issue was the prevalence during the winter months of purulent capillary bronchitis. This was of a peculiarly dangerous type even in unwounded men, and it appeared as an unfavourable complication in many of these cases of septic hæmothorax, though we have no accurate figures to offer in evidence of its frequency as an actual cause of death. Of the eight cases with an apparently simple hæmothorax, three were

unfavourably complicated and perhaps killed by a purulent capillary bronchitis of this nature. If these three and also four cases, in which it was doubtful whether sepsis was or was not present, be set aside, there remains in our records only one death (on the third day) at the base as the direct result of bleeding into the pleural cavity and without any infective or other complication.

Primary hæmorrhage into the pleural cavity therefore must soon come to an end after the chest has been wounded.

Secondary hæmorrhage is very rare and we had only three examples of death from this cause, all of which were septic. In two there was hæmorrhage into the pleural cavity—one on the twenty-ninth day from the laceration of the lung, the hæmorrhage occurring eleven days after a rib resection for septic hæmothorax. In the third case, bleeding took place into the respiratory tubes, so that the man died of a fatal hæmoptysis on the seventeenth day, a vessel having burst close to a small central abscess around a fragment of shell. This was the sole instance in our series of death by hæmoptysis.

In Table B we give a summary of the findings in the no-hæmothorax group of cases, while Table C provides a summary of the visceral injuries met with throughout the whole series of 100 cases.

TABLE B.

THE NO-HÆMOTHORAX GROUP OF CASES, COMPRISING 16 OUT OF THE TOTAL 100 CASES MAY BE THUS SUBDIVIDED ACCORDING TO THE CAUSE OF DEATH.

(1) With lung wound: 9 cases.
- (*a*) Generalized pleuritic adhesions; injury to spinal cord; meningitis: 2 cases.
- (*b*) Spreading septic pneumonia: 7 cases.

(2) Without lung wound: 5 cases.
- (*a*) Base of pleural sac injured; no lung injury; septic liver wound; secondary hæmorrhage from liver: 4 cases.
- (*b*) Split sternum; mediastinitis and general infection by anaerobic gas bacilli: 1 case.

(3) No record of lung wound: 2 cases.
- (*a*) Interlobar abscess; empyema: 1 case.
- (*b*) Empyema: 1 case.

In the group analysed under Table B there are two subdivisions which deserve attention. The first of these, 1 (*b*) embraces 7 cases of spreading septic pneumonia. These will be referred to later (p. 549) in Section V, which deals with the nature of the damage to the lung in wounds of the thorax. In the second of these subdivisions, 2 (*a*) containing 4 cases, the missile had traversed the recessus phrenico-costalis without touching the lung, and death was caused by injury to the liver. A noteworthy feature

of these cases is that no bleeding had occurred into the pleural cavity, a point of some importance which will be referred to later in Section VI (p. 553) in the discussion on the source of the blood in a hæmothorax.

TABLE C.

TABLE OF FATAL THORACIC WOUNDS SHOWING DAMAGE TO VISCERA OTHER THAN LUNG.

Reference number	Spinal cord	Liver	Right kidney	Left kidney	Spleen	Other viscus
*2	x	—	—	—	—	—
*3	—	x	—	—	—	—
11	—	x	—	—	—	—
*12	x	—	—	—	—	—
15	—	—	—	x	x	—
22	x	—	—	—	—	—
26	x	—	—	x	x	—
*28	x	—	—	—	—	—
*41	x	—	—	—	—	—
*70	x	—	—	—	—	—
93	x	—	—	—	—	—
99	—	—	—	—	x	Colon.
102	—	x	—	—	—	Pancreas.
129	—	x	x	—	—	—
131	—	—	x	x	x	—
132	x	—	—	—	—	—
154	—	x	—	—	—	—
164	—	x	—	—	—	—
166	—	x	—	—	—	—
168	—	x	—	—	—	—
173	—	—	x	—	—	—
182	—	x	—	—	—	—
186	x	—	—	—	—	—
*216	x	—	x	x	—	—
218	x	—	—	—	—	—
222	x	—	—	—	—	—
*255	x	—	—	—	—	—
259	x	—	—	—	—	—
266	x	—	—	—	—	—
289	—	—	—	—	—	Stomach.
E3	x	—	—	—	—	—
*E4	x	—	—	—	—	—
E5	—	—	—	—	—	Colon.
*E7	—	x	—	—	—	—
E13	—	—	—	—	—	Heart.
E14	x	—	—	—	—	—

* = No hæmothorax.

In all these cases where there was no hæmothorax, death was really caused by septic infection. In 9 out of the total 16 no-hæmothorax cases the infection was either in the lacerated lung itself or in the pleural cavity; in the remainder sepsis was present elsewhere and added to the gravity of the complicating injury of other organs such as the liver or spinal cord.

The causes of death in the entire series of 100 cases may be finally summarized from the preceding analysis in a way which shows conclusively the *overwhelming importance of sepsis and the slight gravity of hæmorrhage* in determining death from chest wounds at the base hospitals.

Death directly caused by :—

(*A*) Hæmorrhage : 4.
  Primary uninfected hæmothorax : 1 [or (?) 5].
  Secondary, in septic cases : 3.

(*B*) Infection of thoracic contents : 74.
  Infected hæmothorax : 61 [or (?) 57].
  Purulent bronchitis with hæmothorax : 3.
  Septic pneumonia from lacerated lung : 7.
  Empyemata and mediastinitis : 3.

(*C*) Septic injuries of other organs : 22.
  Spinal cord : 8.
  Abdominal viscera : 14.

III.—The Disposition of the Thoracic Viscera in Hæmothorax and in Pneumo-hæmothorax.

A consideration of the disposition of the thoracic viscera in hæmothorax is of prime necessity if one is to have a clear understanding of the physical signs produced by the condition. The state of affairs can be best understood, perhaps, by giving from our records a description of illustrative cases.

(A) *The Aseptic Hæmothorax.*

Case 1.—A Belgian civilian, a trench digger, was shot by a German sniper at close range and died of paraplegia on either the sixth or the seventh day after the wound. Post-mortem, the following condition was found. There is a small skin puncture, a bullet entry wound, just at the superior vertebral angle of the left scapula; the exit wound, slightly larger, being situated two inches above the middle of the right clavicle and one inch outside the posterior margin of the right sterno-mastoid muscle. On removing the sternum we find that the heart is displaced to the left, the apex being about 1½ inches outside the nipple line in the left fifth interspace. The right lung as thus seen from in front looks unusually large and voluminous. Its anterior margin lies well across the midsternal line. It presents the appearance of having been pushed up against the front of the chest, for there are moulded on it the pressure marking of the costal cartilages. Otherwise its surface is normal and no blood can be seen anywhere. In trying to pull the lung out of the pleural sac one breaks rather easily through a lateral barrier of fibrinous adhesions and the hand slips into a large

blood-containing cavity which lies behind it. With further manipulation and removal of the lung from the thorax one can see more easily the nature of the injury and its results.

The right lower lobe, together with the posterior part of the middle lobe, are completely collapsed. The lung here is fleshy and airless, and it is covered with greyish-pink fibrin in irregular patches. In contrast with this collapse, the anterior part of the middle lobe and that part of the upper lobe which lies in contact with the anterior thoracic wall are distended and emphysematous; and there, at the apex, is the wound in the lung, a transverse gutter track with fungating lacerated margins.

The fluid in the pleural cavity is found on measurement to amount to three pints. It is dark in colour and resembles ordinary venous blood except that it shows no sign of clotting and will remain fluid for an indefinite period outside the body. With the removal of this fluid one is able to make out more distinctly the nature of the walls of the hæmothorax cavity and to determine its boundaries. At its base there is the diaphragm, the surface of which is covered by a thin regular layer of fibrin. Its posterior wall is formed by the concavity of the ribs which is lined by one continuous layer of fibrin, $\frac{1}{8}$ to $\frac{1}{4}$ inch in thickness. This fibrinous layer can be readily stripped from the underlying pleura. It is thickest and densest at the base of the pleural sac and thins out as it stretches upwards towards the apex of the lung along the posterior thoracic wall. The anterior limit of the cavity can be definitely determined on the chest wall, for here the fibrin layer on the pleura ends, and if we look again at the lung we see there a corresponding zone of fibrinous adhesions running along its surface. This barrier of adhesions, which forms the boundary between the hæmothorax cavity below and the healthy pleural cavity above, runs from the apical wound downwards and at first forwards along the posterior thoracic wall, then passing in front it swings downwards and inwards to end at the junction of the sixth and seventh costal cartilages. Above this barrier the lung is emphysematous; below it, the lung is collapsed and drowned in effused blood.

This particular case was complicated by a lesion of the third dorsal segment of the cord, which was the actual cause of death, but in its features it may be taken as a fairly typical example of the moderately severe aseptic hæmothorax. The points which the case illustrates may be discussed under certain headings:—

(1) The primary clotting of the effused blood and the disposition of fibrin. The full history of the coagulation changes in the pool of effused blood is much too long to be dealt with here. For present purposes it is sufficient to note that as the blood flows from the wound into the pleural cavity it clots rapidly. But the clotting

is not a massive coagulation such as one finds in a test tube of blood removed from the body. The cardiac and respiratory movements agitate and "whip" the blood during coagulation, so that its fibrin is thrown out and becomes deposited in layers of varying thickness both on the parietal pleura and on that part of the lung which dips into the effused blood. This fibrin may be deposited in one continuous layer or in patches and it is to be found in greatest amount, and often with a more massive coagulum resembling ordinary blood clot, in the diaphragmatic pleural recess and posteriorly in the concavity of the ribs. At first the layer can be readily stripped off the serous surfaces, but later it becomes organized and firmly adherent to the pleura.

The deposition and organization of the precipitated fibrin are at first of considerable advantage to the individual, for the process may not only seal up the wound in the lung, but it may also prevent the subsequent spread of sepsis from a damaged and infected respiratory tract into the pleural cavity. Later, it may of course cripple the chest either by preventing expansion of the collapsed lung, or by forming adhesions, or again by obliteration of the normal pleural recess along the posterior and lateral margins of the diaphragm.

The throwing out of the fibrin leaves in the thoracic cavity a fluid which consists of blood serum together with practically all the usual cellular elements of the blood, that is, it is a fluid which resembles fresh blood, but which has at this stage no power of clotting because it contains no fibrinogen. The experiments upon which this statement is based will be described in a subsequent paper. Such a fluid on centrifuging gives a deposit of red corpuscles with a clear yellow supernatant serum which does not clot either on standing or on the addition of fibrin ferment to it.

Later, however, after a period of time which varies greatly in individual cases, an inflammatory pleural exudate is thrown out and added to the pool of liquid blood. If much fibrin ferment is still present in the hæmothorax after the primary clotting, the fibrinogen of this exudate will also be coagulated within the thorax and so increase the density of the fibrin layer enveloping the lungs. More frequently it escapes this change, and then the sample of fluid taken from the pleural cavity exhibits a coagulation on standing which we term a *secondary* clot. This may be so slight in bulk that no more than a fine spider-web coagulum with red corpuscles entangled in its meshes is developed in the test tube after standing; or it may occasionally be so abundant that the

whole fluid soon clots to a solid dark red mass, and gives the false impression of being a primary coagulum in ordinary effused blood which had never clotted within the pleural cavity after its escape from the vessels.

The largest amount of fluid that we have seen in the autopsy of a sterile hæmothorax was 4½ pints, and it is improbable that this was all fluid derived simply from the original hæmorrhage. In septic cases quantities up to six pints have been observed, the volume having been rapidly increased by the outpouring of inflammatory pleural exudate. In many apparently aseptic cases a slow hæmolysis may occur, so that the serum from the hæmothorax fluid is tinted red with oxyhæmoglobin or a smoky brown with methæmoglobin. The cause of this hæmolysis is unknown to us.

(2) The changes which are brought about in the affected lung by the presence of the hæmothorax. That part of the lung which is submerged collapses by successive stages so that it finally becomes fleshy and airless. The change of course affects the basal portions first. The rate at which the effused blood collects in the pleural sac is very much greater than that which obtains in an ordinary pleural effusion, so that the stages in collapse follow each other more rapidly and the final result is more complete. If the area of collapse embraces the wound in the lung then the process may be helpful in arresting hæmorrhage from the injured lung. Indeed many of the largest examples of hæmothorax we have seen at autopsy have been due to wounds in the lung apices, that is, to wounds situated in that portion of lung where collapse is likely to occur last.

In addition to its effect in checking pulmonary hæmorrhage, there is another undoubted advantage of the condition of collapse in that it prevents the spread of inflammatory bronchial infections through the immobile area. Repeatedly at autopsies we have observed purulent bronchitis or broncho-pneumonia invading all the contralateral lung and the emphysematous area on the injured side, while the collapsed lung has been free from the spreading infection. Actual pneumonic consolidation was found in the contralateral lung only in three cases of death out of seventy-eight with hæmothorax. We have never found the friable changes of lobar pneumonia in the collapsed area submerged below the hæmothorax, though the lung is often so airless that portions of it will sink when placed in water. It is a frequent error in clinical diagnosis for pneumonia to be thought to be present on the side

where a hæmothorax exists, because physical signs simulating those of pneumonia are produced by the collapsed condition of the lung.

A simple method of studying the condition of the lungs in the post-mortem room is that of forced inflation by bellows tied into the trachea. This reveals any islands of pneumonic consolidation between the rest of the elastic lung tissue, and it shows further in late hæmothorax cases that the expansibility of the collapsed lung tissue itself is not lost. When a pair of lungs are distended in this way, the enlargement of the lung on the side of a hæmothorax of two or three weeks' duration is seen to be less than that of the contralateral healthy lung, so that the vertical diameter of the collapsed lung under maximal inflation may attain only a half of that of the other side. This restriction is due to the tough fibrin coat enveloping the pleura. When this coat is incised or stripped away, the collapsed lung becomes at once capable of as great an expansion as is the pulmonary tissue on the opposite side. Where part only of the lung suffers in the process of collapse, the remaining unsubmerged portion becomes unusually voluminous from the development in it of a vesicular emphysema.

This complementary emphysema is much more marked than that which occurs in an ordinary pleuritic effusion and its development may be looked on as characteristic of hæmothorax. The portion of lung affected with this high-grade emphysema takes up that part of the pleural sac which is unoccupied by effusion, and in most cases if free from old adhesions it lies, as in the typical case quoted above, in close apposition to the upper and anterior thoracic wall, while its inner border passes across the midsternal line as it follows the displacement of the mediastinum.

With effusions of about four pints the lung tends to collapse in its entirety so that it recedes to its root, and, if free from adhesions, comes to lie up against the vertebral column. Where, however, it is tied down by adhesions it comes to occupy just such a position as is permitted to it by these adhesions.

(3) The barrier zone of adhesions: The line of fibrinous adhesions which serves as the boundary or demarcation zone between the emphysematous lung above and the hæmothorax cavity below varies considerably in its obliquity. We have seen several instances where the effusion was slight in amount, in which it has been more nearly vertical than in the example we have quoted, so that a larger area of lung has remained in contact with the lateral chest wall. Or again, it may take a less oblique course

starting above and behind at the level of the fourth, fifth or sixth dorsal vertebra, so that there is a considerable area of lung in contact with the posterior thoracic wall in its upper part.

Doubtless these differences are partly due to the different postures assumed immediately after the wound. Some patients can lie down at once under shelter in the trenches and remain there for hours, others are compelled to walk some distance before they can receive assistance.

The accompanying drawings, figs. 1 and 2, represent diagrammatically the distribution of the pool of effused blood in relation to the other thoracic contents as it occurred in the typical case of simple hæmothorax just described. In the front view, fig. 1, the black area represents the portion of thoracic wall with which the fluid pool of blood comes into contact anteriorly. The part of lung which is submerged in this pool of blood is collapsed and airless. The larger stippled area in fig. 1 shows the extent of the emphysematous lung which lies above the pool, and which is separated from it by an oblique line of fibrinous adhesions. The right pleural reflection is pushed across the middle line behind the sternum so that the mediastinal contents are displaced to the left.

Fig. 2 shows the extent of the hæmothorax cavity as seen from behind. The apex of the cavity coincides with the wound in the apex of the lung, and the lung is everywhere separated by fluid blood and clot from the posterior thoracic wall.

So far then we have dealt with the plain straightforward hæmothorax. There are, however, anomalous cases which do not conform with the type just described. The lung bleeding may be so slight in amount that no pulmonary collapse results and the effused fluid may be spread out as a thin layer between lung and parietal pleura. Also, under certain conditions which are not altogether obvious, the effused blood may be localized to one particular part of the pleural cavity and may come to assume a position which is not apparently decided by the gravitation factor which governs ordinary cases. In such instances, which are relatively rare, the fluid usually collects over the point of injury in the lung and becomes delimited to this region either by barriers left by an old pleurisy, or through the early formation of fresh fibrinous adhesions. In the latter event it is necessary to assume that bleeding does not occur in one rapidly poured out extravasation, but rather that there is a slow hæmorrhage in which each accession to the effused pool of blood clots in turn and in which the resulting fibrin, forced out to the periphery or margin

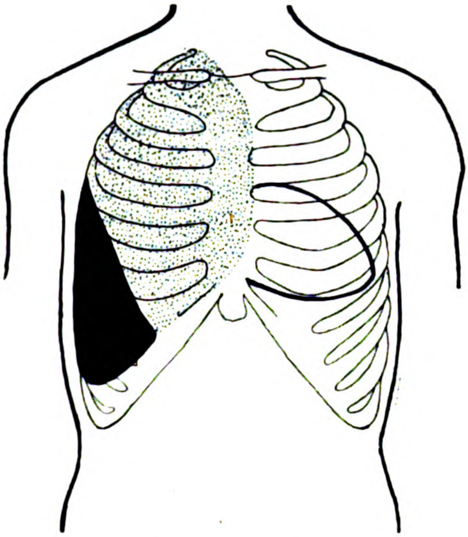

FIG. 1.—Outline diagram of anterior aspect of thorax to illustrate the relationship to the chest wall of the simple hæmothorax of moderate size described in the text.

Black = hæmothorax. Stippled = emphysematous lung.

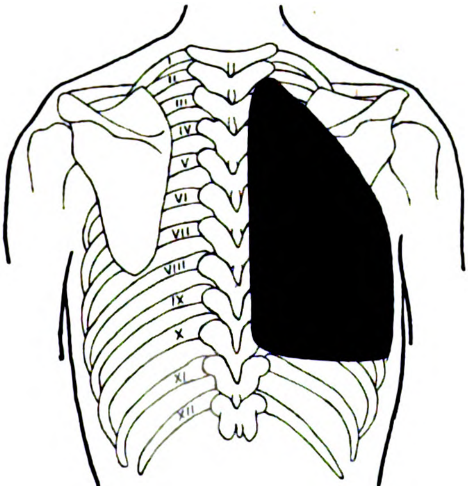

FIG. 2.—Outline diagram of posterior aspect of thorax shown in fig. 1, the black area indicating the distribution of the hæmothorax.

of the pool, prevents by means of adhesions any overflowing into the general pleural cavity.

The existence of old adhesions is a factor which may be of considerable influence on the disposition of the thoracic viscera in hæmothorax. If the entry or exit wound in the lung occurs over an area which is firmly adherent to the thoracic wall, then there is no chance for effused blood to reach the pleural cavity. We have seen such a case with generalized pleuritic adhesions in which the blood collected outside the parietal pleura so that this was stripped off the underlying ribs and intercostal spaces. If there are no adhesions in the region of the lung wound, but if these exist elsewhere in the pleural cavity, then there may result an abnormally placed hæmothorax or one of several irregular loculi. Quite apart from the barriers imposed by them to the extent and distribution of an intrapleural bleeding, adhesions may have much influence on the changes undergone by the lung itself. Thus an adhesion may tie down a portion of lung in such a position that it undergoes a complete collapse from which it might otherwise have escaped; or again, an apical adhesion may serve to keep in position a volume of lung so that it escapes submersion and consequent collapse.

(B) *The Septic Hæmothorax.*

Case 2.—The following description may be taken as a good example of the appearances found in an early septic hæmothorax, the infection being due to a streptococcus. It is that of a man who died on the seventh day after being wounded by a fragment of shell.

There is only one external wound, a fairly large septic track about the size of a florin, situated over the front of the left shoulder and about two inches below the level of the left acromio-clavicular articulation. On opening the thorax one finds that there is no lung up against the anterior thoracic wall, for the left pleural sac appears to be completely filled with dark blood. The heart and pericardium have been displaced to the right so that the right cardiac margin lies two inches beyond the right sternal border. The fluid from the left pleural cavity measures four pints and it consists of dark red blood containing soft friable clots. The left lung is in a condition of partial collapse, being bound by old adhesions over its base to the diaphragm, and above at its apex to the tip of the pleural sac. Thus tethered, the lung lies stretched out in the pleural sac with a cushion of blood separating it from the chest wall in front, at the side, and behind. By examining the excised lung and the upper chest wall it becomes possible to determine the track of the missile. The first rib is splintered along its lower border in the mid-axillary line, although it is

not broken through, and here there is a larger irregular tear about one and a half inches long in the parietal pleura. The lung wound consists of a side-to-side penetration, about two inches from the extreme apex, the track running from without inwards. The way into the lung is represented by a round clean-cut hole about one-quarter inch in diameter and it is plugged with blood clot. The way out of the lung is a larger ragged wound with lacerated lung tissue forming its irregular borders and it contains several small spicules of bone which have apparently been splashed out of the body of the third dorsal vertebra on its left side where a piece of shell casing lies embedded.

So far the appearances noted are no more than those we should expect to find in an unaffected hæmothorax, and we must examine still further for evidence of sepsis.

Most of the lung surface is covered with a coarse reticulum of fibrin. This can be rubbed off or pulled away fairly easily, and underlying it one comes across the dense fibrin layer of the primary clotting, which is firmly adherent to the pleura. The lymph gets its shaggy appearance from fibrin laid down after the primary clotting, and this second coarse reticular deposit is no other than the fibrin resulting from the inflammatory reaction produced in the pleura by infection of the pool of blood with some organism. The parietal pleura shows exactly the same condition, and over the base of the pleural sac in the concavity of the ribs one can scoop off dense jelly-like masses of plum-coloured clot, where the secondary inflammatory clotting has picked up in its fibrin meshes the free fluid blood left over from the primary clotting.

There is commencing pleurisy at the base on the right side, with a few patches of bronchopneumonic consolidation in the right lower lobe. On squeezing the cut surfaces of the right lung thick viscid beads of pus exude from the cut bronchioles, showing the existence of a purulent bronchitis. Further, on opening the pericardium we find it to be filled by a semipurulent exudate with shaggy fibrin deposited on the surface of the heart.

That, then, is the state of affairs in the septic hæmothorax of short duration. The picture, of course, varies considerably with the nature of the infection and the time it has persisted. The secondary inflammatory deposit of fibrin from the pleural effusion may be very slight, or it may be a thick, ragged, shaggy sponge-work, containing gelatinous pus in its interstices. Where a hæmothorax has become infected with gas gangrene organisms, the deposit may show "rain-drop" markings due to the development in it of large bubbles of gas. It is unusual to find this septic secondary deposit without any evidence of the primary clotting. In other words, it is practically always superadded to the original

deposit of fibrin from the blood—a fact which is in keeping with the proof we have obtained that generally the effused blood clots and throws out its fibrin almost immediately. Further, even where sepsis has persisted for some time, the original fibrin layers remain proof to the bacterial invasion, and continue to show to the naked eye the same appearance that one gets in a healed aneurismal sac.

The fluid contents of the pleural cavity may, as in the example here related, give little indication to the naked eye of the presence of sepsis. The foul odour that results from infection with anaerobes is often characteristic, and a buff-coloured deposit caused by the addition of pus cells to the blood gives certain evidence of infection. But where there are no such frank signs it becomes necessary, as in the streptococcal case just described, to go beyond the affected pleural sac and to look for signs of spread of infection into the pleural sac of the opposite side, or into the pericardium—though this is rarer. In doubtful cases the final proof of infection rested on the evidence obtained by microscopic and cultural examination of the fluid found in the pleural cavity.

(C) *The Pneumo-hæmothorax.*

No case of simple pneumothorax without effusion occurred in this series of one hundred deaths. We have, however, records of twelve cases of pneumo-hæmothorax, that is, of cases in which gas or air has been found in the pleural cavity together with blood.

The development of free gas from the growth of anaerobic bacilli within the pleural sac is a much more common cause of this condition in fatal cases than is a leakage of air into the pleural cavity. It is, therefore, necessary to make a very clear distinction between the two ways in which the pneumothorax may originate. The word pneumothorax itself has been used for so long to describe simply a condition in which free air is present in the pleural sac, that it must be preserved in that general sense. To speak of a "gas" pneumothorax, in contrast with an "air" pneumothorax, either of external or of internal origin, is convenient but tautological. We have chosen for precise description the more cumbrous adjectives, *endogenous* and *exogenous* respectively.

When atmospheric air gains access to the pleural cavity, either through a wound in the external thoracic wall or from a leak in the respiratory track, an "exogenous" pneumothorax is produced. In contrast with this type is the "endogenous" group of cases, in which gas, always of an offensive odour, is generated by organisms growing in the hæmothorax fluid. Of the twelve fatal cases referred

to above, nine belonged to this endogenous class, in which the pool of blood had been infected with a gas-forming anaerobe.

In addition to this difference, between the two ways in which the pneumothorax may be produced, it is necessary to consider a further distinction that is based upon the distribution of the gas or air in relation to the other thoracic contents. The cases in this respect fall into two groups:—

(1) The volume of air or gas is freely *mobile* above the fluid within the pleural sac, so that its position alters with the posture of the patient. The lung is completely separated from the parietal pleura by the collection of fluid below and by the air above, and its degree of collapse varies with the volume of these abnormal occupants of the pleural sac.

(2) The volume of air or gas is *fixed* in position, the immobility of the stationary loculus being determined by the formation of adhesions at its confines, or by the fact that it originates as a localized development of gas from anaerobic organisms in a mass of clotted effusion.

Finally, there comes an important clinical distinction, namely, that between the *open* and the *closed* forms of pneumothorax. The former may have remained open from the moment of the wound onwards, or the opening may have developed later by a fistulous leak through a septic wound, either externally through the chest wall or internally through the lung. This latter condition is rare. A pyo-pneumothorax results, and though atmospheric air passes in and out through the hole, the septic processes within generally add an offensive odour to the expired air.

Endogenous Pneumo-hæmothorax.—The gas has, in our experience, always been produced by the growth in a hæmothorax of anaerobic spore-producing bacilli. It has invariably an offensive smell, often resembling that of sulphuretted hydrogen or rotten eggs, and this odour is so characteristic, that with a little experience it may be safely accepted as proof of infection by these bacilli. It often accumulates under considerable pressure, so that when a small canula is introduced at autopsy through an intercostal space into the collection of gas, the latter escapes through the tube with a noise and will burn with a bluish flame if a light be applied to it.

Nine out of the twelve cases of pneumo-hæmothorax in our series belonged to this group. The disposition of the thoracic viscera as found in the ultimate examination of these cases was not precisely that which existed during life, for it is likely that

there was an increased development of gas after death. The collection of gas may be mobile and free above the septic blood in which it was generated, while the lung is completely collapsed. Of this type four cases were seen. Or it may, as in three other examples, be fixed in position by adhesions, so that it lies between the pool of blood below and the unsubmerged lung above. And lastly, it may be loculated, as in two cases where the gas production had occurred at isolated points in the midst of an infected hæmothorax. In one autopsy, for instance, a foul-smelling loculus was found lodged between the upper and middle lobes of the right lung, while a second loculus was fixed between the inner surface of the lung and the pericardium. Death in all these cases seemed to have been caused by the toxic effects of the infection rather than by the mechanical results of the pneumothorax.

Exogenous Pneumo-hæmothorax.—It is probable that in most cases of lung injury a certain amount of air escapes from the damaged bronchi or bronchioles along with the blood which is poured into the pleural cavity. Under ordinary conditions, however, this air would appear to be so small in amount, or it is absorbed so rapidly that, post mortem, the case presents only the features of an ordinary hæmothorax. On several occasions where, clinically, the Skodaic phenomena, such as a tympanitic percussion note and diminished breath sounds over the emphysematous lung above a hæmothorax, were so exaggerated during life as to raise doubt whether air as well as blood might not also be present in the pleural cavity, special care was taken to test for its presence by pushing a fine trochar through the chest wall before removal of the sternum. There was no free air, and the emphysematous lung was found to be in the closest apposition to the anterior thoracic wall over the precise area where the Skodaic phenomena simulating pneumothorax had been observed. It was relatively rare for us to find any evidence of the presence of exogenous and inoffensive air at an autopsy on a case of closed wound of the chest.

(*a*) *Closed Type.*—Two such cases were observed, in each of which the wound had been a side-to-side penetration of the apex of the lung, and the top of the pleural sac was occupied by blood, together with air that had escaped from the injured lung, the entire collection being confined to the summit of the pleural sac by fibrin adhesions. In each of these death was caused by spinal injury, and the small loculated pneumothorax was revealed only by the chance that it was associated with this fatal complication.

There was also one example of mobile pneumo-hæmothorax with a fully collapsed lung, which died on the third day.

In none of these exogenous examples was death caused by the pneumothorax itself. Cases of simple pneumo-hæmothorax are either rapidly fatal owing to the extent of the damage to the thoracic contents, so that they die close to the fighting line, or else they make a satisfactory recovery without any unusual tendency to the development of sepsis. We have seen no example of that particular condition, the Spannungs-pneumothorax of foreign writers, in which a communication between the pleural cavity and the bronchial air channel is valve-like in character, so that the forced pressure of each expiratory cough drives more air out into the pleural sac, because its escape through the closed glottis is momentarily arrested during the instant of the cough. The result would be an increase of volume of the pneumothorax under a steadily increasing intrapleural pressure which soon becomes much greater than that of the atmosphere, and, unless relieved by puncture of the chest wall, results in death.

(*b*) *Open Type.*—If the wound in the chest wall has remained open to so late a date as that of arrival at the base, then the pleural cavity will certainly have received infection from the external skin surfaces and the case will present itself as one of pyo-pneumothorax. It is sometimes difficult in such examples of pyo-pneumothorax, where air and purulent blood have been leaking from a hole in the chest wall, to ascertain at what date the air leak had commenced. It may have been coincident with and continuous since the infliction of the wound, or it may have developed later by the bursting outwards through the imperfectly closed wound of a hæmothorax which was increasing in volume because it was septic. Death, when it occurs, results either from sepsis caused by the imperfect drainage or from complications such as purulent bronchitis. The pathological appearances do not require a close description in respect of the character of the pus and blood clot which overlie the collapsed lung. But a point of very great interest is that of the extent to which the lung is found to be collapsed in these open cases. The outstanding fact that is noticeable in almost all such autopsies is that the lung is only partly collapsed, and that its upper area is generally attached by adhesions to the chest wall. Such a position is easily comprehended when a pyo-pneumothorax develops late by a secondary leak from a septic hæmothorax through a hole which at first was closed, for it is obvious that the lung will not collapse when it is attached by adhesions along the

boundary of the original hæmothorax. The condition then is identical with that which obtains when a septic hæmothorax is drained surgically by resection of a rib. The lung does not collapse any further, and indeed, it may expand anew with great rapidity if the drainage is good and made at an early date. But when the wound in the chest wall has clearly been open ever since its infliction, it might be expected that the lung would collapse completely and that a pneumothorax of the entire pleural cavity would be established. Actually this is not found. Complete collapse was indeed noted once, in a case of pyo-pneumothorax which died on the forty-fourth day. In this the lung was flattened against the vertebral column and covered over so completely by a dense uniform pyogenic membrane that it could only be discovered by close dissection. But the condition in this patient was originally and really that of a closed pneumothorax, which had been septic, and was not opened by resection of a rib until the thirty-eighth day, when the operation was too late for the lung to re-expand. The condition that is more likely to be found in an open wound is well illustrated by the following case :—

Case 3.—S., Royal Scots. Tangential bullet wound across front of lower half of right chest, entering at fifth rib in axilla and escaping through the sternum which was split across at the level of the fifth chondral articulation. This exit wound gaped widely open, and the lower fragment of the sternum moved separately, being pulled upwards with each inspiration. Air passed freely in and out, and purulent blood poured out of the hole when the patient was rolled on to his face. Death on fourteenth day. The empyema cavity was found to be limited at the third rib above in front, where the lung was fully expanded and adherent to the chest wall. Below this the lung was only partly collapsed. From the nature of the injury it is almost certain that the anterior wound must have remained continually open, except in so far as it was covered by surgical dressings. Yet the lung was collapsed only in its lower half and a complete pneumothorax had not been established.

IV.—The Injury to the Chest Wall.

There was often difficulty in determining the exact nature of the missile that had penetrated the chest, and even prolonged search failed to reveal a bullet or shell fragment where one could with good reason assume that it had remained inside the body. Out of sixty cases in which the penetrating missile was identified, fifty-five per cent were found to be due to bullet, the remaining forty-five per cent to shell fragments, shrapnel balls and pieces of grenades and bombs. There were no bayonet wounds.

(1) *The Skeletal Damage.*

The number of cases in our series in which the notes record injury of bones in the thoracic wall is seventy-four, but this figure probably understates the actual percentage, for we did not always observe the facts relating to skeletal damage.

The ribs, as one might expect from the amount of chest wall which they occupy, suffer in nearly all cases of skeletal injury, and damage to the vertebral column, clavicle or scapula has rib injury as a rule associated with it. In most cases of bullet wound the ribs are completely divided and suffer well-marked comminution. On two occasions a rifle bullet was found to have penetrated a rib at right angles without any actual costal disruption. In each case there was a round clean-cut hole on the outer surface of the rib, while from its inner surface there projected towards the pleural cavity from the margin of the wound a cone of fine bony spicules.

We have also come across several instances of notching of a rib at its upper or lower margin so that a rough-edged crescentic lacuna results. But the perforation and notching of a rib are unusual injuries which can occur only where the course of a bullet is at right angles to the rib at the point of impact. They are moreover in themselves of little consequence, when compared with the more severe injury one usually finds. As a rule, rib damage due to the impact of a bullet at relatively close range is disruptive. This disruption occurs especially over exit wounds, because here there is less support for the convex outer surface of the rib. It becomes more obvious too in this situation because the fragments of comminuted bone tend to be driven outwards. The resulting rib fragments vary much in size. Small sharp acicular splinters may be carried for a distance of even several inches into the lung substance.

Where a bullet traverses the thoracic wall obliquely or tangentially a whole series of ribs may be fractured, and not infrequently when this happens the parietal pleura underlying each rib is penetrated and torn by comminuted rib spicules or by jagged rib ends while the pleura covering the intercostal spaces may remain undamaged.

The primary fracture of a rib, that is the fracture due to the direct blow of the missile, is at times complicated by a secondary fracture which is situated some distance from the original injury. This *indirect* fracture occurs occasionally where only one rib is involved, but it is most frequent where a series of ribs is implicated by a tangential wound of the thoracic wall. The particular point

at which this secondary fracture occurs most often is at, or in the vicinity of, the angle of the rib, and it is a curious fact that inward displacement of the fractured ends with consequent laceration of the pleura and even of the lung is often much greater at the site of the indirect than at that of the direct fracture. The following case illustrates this feature:—

Case 4.—P——, Northamptons: November 16, 1915. Wounded by fragment of shell, which tore the back of the left chest from above downwards, splitting the scapula vertically from top to bottom (fig. 3). Died on the eighth day after the wound. While in hospital there was no outward leakage through the dorsal wound of either blood or air from the pleural cavity. Exploration of the left chest yielded a hæmothorax fluid which was infected with streptococci and staphylococci. The patient died of sepsis and contralateral pneumonia. No operation was attempted. The left pleural cavity was found to contain inoffensive air under pressure and about fifty ounces of "fluid blood." The left lung was collapsed and lay in close contact with the posterior thoracic wall and the septic blood clot below. It was deeply bruised behind but the laceration was slight. There was early pericarditis, and the lower lobe of the right lung was consolidated by pneumonia. Removal of the parietal pleura revealed the damage to the ribs that is shown in the radiogram (fig. 4). The blow had caused direct fracture of seven ribs from above downwards, and indirect fracture near the angles of six ribs, with forward displacement through the pleura of fractured ends from three of these. The source of the infection was from outside by skin cocci. The air in the pneumothorax was exogenous, but probably derived from the lung and not directly from outside through the parietal wound. The source of the bleeding was not proved. (Specimen in War Office collection.)

In cases of injury due to high explosive shell fragments the bone damage is, as one might expect, much more extensive than in that due to bullet, but often there is little difference in the injuries produced by the two types of missile. A small piece of shell, if it traverses an intercostal space, may produce the lesions one associates with a clean penetration by bullet; or again, an oblique wound either at its point of entry or of exit may reproduce the features of injury by a larger shell fragment. With the advent of sepsis pieces of comminuted rib rapidly necrose and this may be a factor of much import in the course and history of a wound of the thorax.

The costal cartilages are injured in much the same way as are the ribs, except that they show little tendency to splintering. We have seen only two cases of injury of the sternum at autopsy, probably because the majority of such cases are associated with

fatal injury to the heart and great vessels. In one of these the manubrium sterni was penetrated so that a piece of shell wrapped up in khaki came to lie in the anterior mediastinum, and the man died of a generalized gas gangrene infection. In the other the lower part of the sternum with the cartilages on the left side were extensively damaged in an oblique wound due to bullet (Case 3).

The scapula and the clavicle frequently suffer and are alike in that they both show, as a rule, much comminution and disruption.

Where the bodies of the vertebræ are damaged there is often a localized fine comminution into small sharp irregular fragments, and it is not infrequent to find that these have by a process of splashing or ricochet become embedded in the adjacent lung wound (see Case 2).

(2) *The Damage to the Soft Tissues.*

The degree of muscle laceration and tearing depends on the extent of damage to bony structures, and wounds of muscle are of little consequence except in so far as they may be accompanied by vascular damage. With regard to the intercostal vessels it is very difficult indeed to obtain absolute evidence that they have been injured, and one has usually to infer such an occurrence from the presence of hæmorrhage into the thoracic wall. Generally speaking, no signs of parietal hæmorrhage can be detected where there is clean penetration of the chest wall without bony injury, and indeed such signs are obvious only in a minority even of those cases which are associated with rib damage.

The nature and extent of the damage sustained by the parietal pleura in penetrating injuries of the chest wall is dependent on two factors. There is the primary injury effected by the missile and there is also the injury produced by pieces of broken rib. A bullet passing vertically through an intercostal space gives no more than a small puncture wound of the parietal pleura. An obliquely travelling bullet produces an oval slit with tight-drawn crescentic margins, and a shell fragment frequently gives rise to a large, jagged, irregular tear. The multiple pleural tears corresponding to the fracture of overlying ribs that one gets in oblique and tangential wounds of the thoracic wall have already been referred to.

V.—The Damage to the Lung.

A wounded lung taken from a case of hæmothorax is often so completely ensheathed in firm clot that it is impossible to discern any injury without careful stripping away of the fibrinous layers

which surround it. Unless this can be done so that a minute search of the lung surface can be carried out, a lung wound can be readily overlooked. It is natural to suppose that the wound produced in a lung by the passage of a bullet would be slight and trifling, for one might reasonably assume that the track would be speedily closed and eventually obliterated because of the elasticity of the lung tissue. But we have met with very few of these simple puncture wounds at autopsy. In the majority of cases there are superadded to the simple puncture the effects of laceration, contusion and hæmorrhage, which may be followed still later by the changes which are induced by bacterial invasion. The actual amount of lung damage and the distance of penetration vary, of course, with the shape, size, and velocity of the penetrating missile. A bullet, for instance, in traversing the thorax may pass completely through one or both lungs, whereas a spent shell fragment may penetrate but a very short distance. We have not met with a single example of a rifle bullet embedded in the substance of the lung, though shell fragments are quite commonly found in that position. If an entering bullet fails to pass completely through the thorax it is generally arrested by the tough skin or by the ribs, from which it drops back into the pleural sac. Shell fragments are even more liable to rebound from the ribs and lie free in the pleural cavity.

The path taken by the missile, as seen at autopsy, appeared generally to have been a straight line without zigzag angles by deflection from the inner surface of the bony cage. But in one curious case a bullet entered on the left side between the first and second ribs, took a twisting path of a couple of inches through the lung, and escaped by a hole in the second interspace immediately below the first, so that it curved round the second rib without injuring it in any way and had not touched bone in any part of its course.

The point with regard to lung wounds which has been strongly impressed upon us in the course of our observations is this: Whatever be the penetrating missile, and whatever the nature of the damage caused thereby, the lung wound in the majority of fatal cases is characterized by laceration and bruising with wide extravasation of blood into the tissues surrounding the track.

Consequently, a transverse section across the lung shows not a slight indefinite wound such as might be produced by a large exploring needle, but a well-defined clot containing lumen, surrounded by rigid walls of solid hæmorrhagic lung tissue. The

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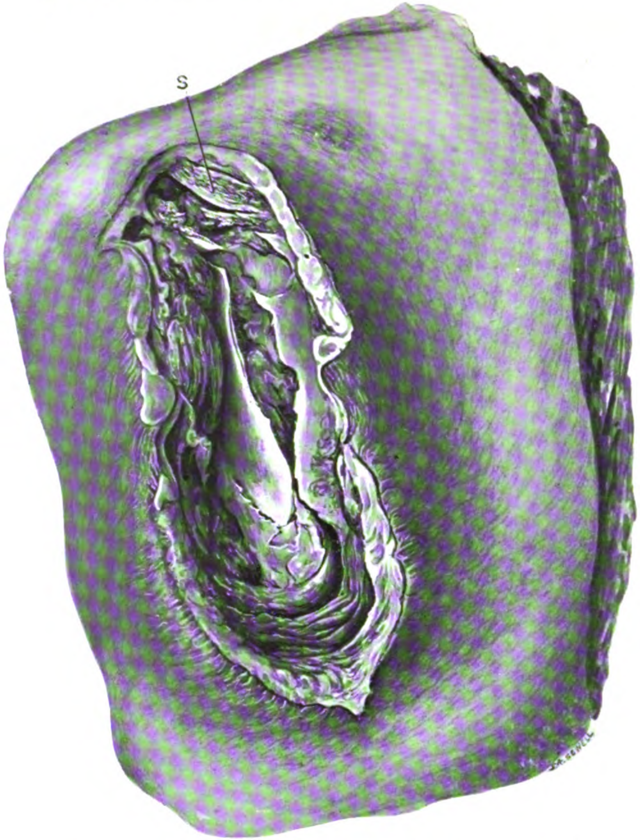

FIG. 3.—Drawing of back of left chest, which was torn by a fragment of shell passing from above downwards (Case E20). The scapula, S = its spine, was partly denuded of its coverings and lies split in two at the bottom of the gaping septic wound. There was no direct opening into the pleural cavity.

FIG. 4.—Radiogram by Captain H. E. Gamlen, R.A.M.C., of the left thoracic wall from Case E20. The lung has been removed. D.F. shows the *direct* fracture of each rib from 3 to 9 in a line immediately underlying the wide gap in the shadow of the scapula, which corresponds to the split shown in fig. 3. Ribs 3 and 4 on this line have suffered a slight downward displacement of their fragments along the direction of the blow by the main mass of shell casing. A fragment of metal has travelled sideways and caused a separate comminuted fracture by direct impact on rib 7, where the intercostal nerve was displaced but not torn. I.F. marks the *indirect* fracture of ribs 2, 4, 5, 6, 8 and 9 at a point close to their angles, with displacement forwards and inwards to the middle line of the outer fragments of ribs 4, 5, and 6. Each of these ends had penetrated the pleura.

alveoli and the interalveolar spaces in the bruised lung tissue have become flooded with blood, so that one gets an appearance which resembles a lung infarction and may extend over several inches around the wound. As a rule, this area of bruising clears up rapidly, the blood being expectorated, as it is from an ordinary true infarct. Hence it is much more obvious and wider spread in lungs examined two or three days after the original wound than it is in those of a later date. The zone of lacerated and hæmorrhagic tissue surrounding the track of a wound varies much in its distribution. As a rule, it is more marked at the exit than at the entry point in the lung. At times the exit wound presents a curious mushroom-like appearance from the protrusion of bruised tissue round which blood clot has collected, a condition which almost reminds one of that found in certain instances of secondary lung metastases due to rapidly growing hæmorrhagic new growths. We have not seen radiating fissures around a gunshot wound of the lung similar to those which are often produced in the solid organs such as the liver or spleen.

The damaged lung might be expected to form a suitable nidus for the development of micro-organisms, which may be introduced with the entering missile from without or may be derived from the lumen of the respiratory passages. But secondary inflammatory processes do not very often supervene on lung injury. Those which do occur may be either localized or disseminated throughout the organ. Where a missile is retained in the lung or where fragments of comminuted bone have been driven into its substance, the advent of sepsis may occasionally produce breaking down of the damaged lung so that a cavity is formed. The same result may ensue by the spread of sepsis through lacerated lung where no foreign body is retained. The cavity if it persists long enough becomes lined with a definite pyogenic membrane, and it may be traversed by unsupported pulmonary vessels running across it just as in a tuberculous cavity. In one such case of our series death resulted from secondary hæmorrhage. Again, inflammatory processes starting in the region of the injury may spread into surrounding healthy lung, so that broncho-pneumonic patches occur at some distance from the original wound. Localized sepsis and lung destruction such as that occurring round a foreign body or in the immediate vicinity of the wound we have found both in collapsed and in uncollapsed lung, whereas septic changes spreading some distance beyond the injury we have found to be unusual in collapsed lung.

The cases which show best the septic broncho-pneumonia

starting from the wound and spreading throughout the lung have been cases of lung laceration with no hæmothorax ; and it is likely that the spread in these cases is chiefly by respiratory suction from the septic lacerated wound. The converse explanation would serve to account for the localization of the septic process in the collapsed lung, where aspiration as a factor in the process of spread of sepsis is excluded.

The occurrence of septic broncho-pneumonia in uncollapsed lung is always a serious danger in glancing wounds of the chest wall, where ribs are smashed but where there is no hæmothorax to cause a protective collapse of the lung. Another event to be apprehended in wounds of this type is an infection, usually streptococcal (spreading from the injury), which rapidly leads to pleurisy, effusion, and an empyema which is the more serious because the toxins produced in it are quickly absorbed into the circulation through pleural surfaces which are not covered by a layer of clot from hæmothorax.

A reference back to Table B shows that of the sixteen cases included in this, the group of deaths without hæmothorax, seven succumbed to septic broncho-pneumonia, and on analysis these cases are found to present certain features in common. In all the damage to the thoracic wall was considerable, and in some it was more extensive than that of any case in which hæmothorax was present. For example, in two of the series, seven ribs were broken and cominuted on the wounded side, both direct and indirect fractures being present.

The bullet or shell fragment which produces such damage to the chest wall is taking, as a rule, a tangential course, so that the injury to the subjacent pleura and lung results not so much from the missile itself as from displaced fragments of broken bone. It is under these conditions that actual penetration of the lung is at a minimum while bruising of the lung is at a maximum. Because, therefore, the lung injury is of the nature of a contusion, and inasmuch as it is the smaller vessels in the more superficial parts of the lung that are directly damaged, the extravasated blood infiltrates into the lung tissue itself rather than into the pleural sac. When sepsis, either from within or without, is implanted on this area of contusion and laceration, the process will spread rapidly as the result of the respiratory movements in the uncollapsed lung.

Old pleural adhesions may have an equally unfortunate effect, since they may prevent the formation of a hæmothorax, and so indirectly facilitate the spread of infection through the lung.

The sum of these observations is that laceration of the lung

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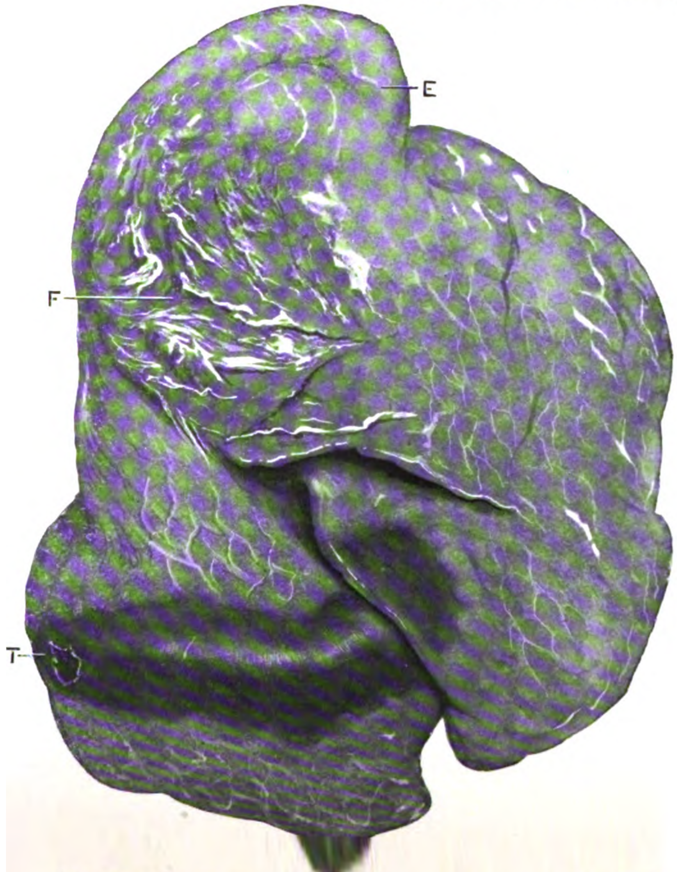

FIG. 5.—Drawing of lung showing hæmatoma accompanying a penetrating wound.

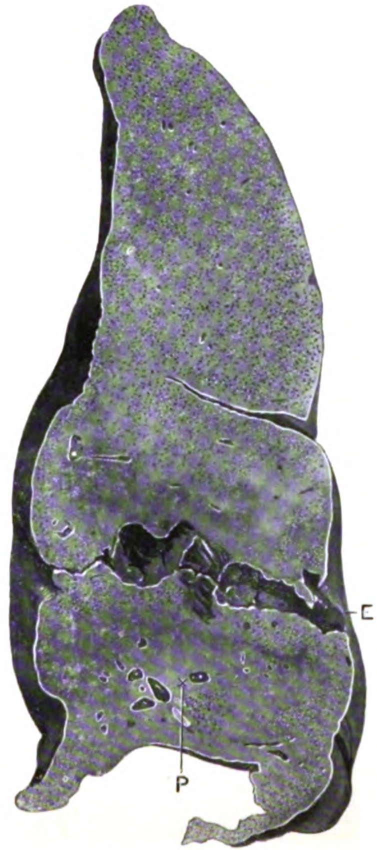

FIG. 6.—Drawing of lung to show lacerated and septic wound track.

frequently occurs in gunshot wounds of the chest, but that it is relatively harmless provided that a hæmothorax is formed to cause collapse and hinder the spread of infection.

The accompanying drawings (figs. 5 and 6) illustrate very well certain of these features of the injury to the lung.

For the specimen depicted in fig. 5 we are indebted to Captain Adrian Stokes, R.A.M.C. The lung is taken from a case which died in the first few days after the receipt of the injury. The upper lobe is in a state of compensatory emphysema, the condition being most in evidence at the apex and along the anterior margin of the lung (E). On the posterolateral surface of the upper lobe is a rough coating of fibrin (F) deposited as the result of the primary clotting of the hæmothorax blood. Its position marks the apex of the hæmothorax cavity in the chest.

The lower lobe is much diminished in size, being in a condition of collapse. It is this part of the lung which has lain submerged in the pool of blood. A sausage-shaped wound track caused by a shell fragment is seen crossing it transversely. One extremity of the track (T) is to be noted at the posterior lung margin as a gaping clot-containing aperture. The channel made by the missile is surrounded by lung tissue, into which hæmorrhage has taken place. The pleura over this hæmorrhagic lung is tightly stretched and glistening, and the whole stands out in high relief above the surface of the rest of the lung, the raised appearance being accentuated by the collapse of the surrounding lung. This contrast, it will be noted, is less marked where the track involves the middle lobe, because here the surrounding lung is not collapsed.

The drawing is introduced to illustrate the hæmorrhage round a wound track when a missile penetrates the lung. As a rule, this hæmorrhage is a feature of the earlier stages of a lung wound, so that the track can be felt as a mass or band of solid tissue running through the substance of the lung. Later, however, the track becomes less easy to palpate, for the hæmorrhage tends to disappear by absorption or expectoration in much the same way as does a pulmonary infarct.

Fig. 6 represents a later and more severe type of lung injury. It depicts in section a right lung taken from a case in which the findings were as follows :—

Case 5.—A., Roy. Berks. There was a ragged septic entry wound low down on the right side of the chest in the posterior axillary line. The eighth right rib immediately subjacent to this was completely broken through. The missile, a piece of shell casing about ½ inch in diameter, had passed through the lower lobe of the right lung from without inwards

had then traversed the anterior part of the body of the ninth thoracic vertebra with a jagged entry and a spiculated exit wound, and then, pursuing its course through the left lower lung from within outwards, had come to rest just under the visceral pleura on the external aspect of the left lung. The right pleural cavity contained about ½ pint of old blood, whereas on the left side there was a fresh hæmothorax of 3½ pints, the result of a secondary hæmorrhage from the lung wound into the pleura. It was this secondary hæmorrhage which caused death.

The specimen shows a very rugged wound track, running through the right lower lobe. On the external surface (E), the point of entry, is a gaping wound with irregular margins and slightly depressed beneath the surface. In the track of the missile there has been considerable laceration with subsequent necrosis of lung tissue, so that a wide uneven channel has resulted. The dark areas above and below the track represent hæmorrhagic lung tissue, and this, it will be noted, is most marked at the end of the track, where it shows itself as a wide raised ring surrounding the wound of exit. Still further outside lie small irregular patches (P) of septic broncho-pneumonic consolidation, specially obvious at the base of the lung below the wound. The rest of the lung shows slight compensatory emphysema.

The specimen, then, exhibits a more severe type of lung injury, and one of longer duration than that depicted in the preceding drawing (fig. 5). There has been laceration of lung tissue followed by necrosis, and a localized spread of infection in the form of septic broncho-pneumonia into the surrounding healthy lung.

VI.—The Origin of the Bleeding in Hæmothorax.

The pool of blood which collects in the pleural cavity may be derived from two different sources. It may come from vessels which run in the chest wall, or it may result from injury to some of the thoracic contents. It is, therefore, either parietal or visceral in origin, and in view of the widely divergent opinions in this matter, it becomes necessary to consider in some detail the contribution that may be furnished by either of these two possible sources of hæmorrhage, and to assign as far as one can to each its share in the production of hæmothorax.

Intrapleural bleeding produced by damage to the heart or great vessels must result in death which is sudden or but short delayed, so that such cases practically never reach the hospital base. The term visceral bleeding then would refer to bleeding of pulmonary origin, and its relation to the clinical hæmothorax must be taken to refer only to hæmorrhage derived from the smaller lung vessels,

for, with one doubtful exception, no case has been found by us at the base of injuries involving the hilum of the lung and the larger pulmonary vessels.

It became obvious at the very beginning of our observations that the experience of lung wounds gained in the South African War was very different to that obtained in the present campaign. In discussing the wounds produced in lungs by bullets of small calibre, Surgeon-General Sir George Makins has said[1]: "The most striking examples of small even tracks are seen on the other hand in puncture of the elastic and practically homogeneous lung tissue, where the wounds are extremely small." Again he says (p. 396): "In point of fact there is no reason why a perforation by bullet of small calibre should be much more feared than a puncture from an exploring trocar, and the danger of the two wounds is probably very nearly the same."

These remarks based on observations made during the South African campaign would apply to but few of the cases of lung injury which have come to autopsy during the present war, for the short-range bullet and the shell fragment have together produced a pathological picture which has but little in keeping with that previously observed.

We have already described the nature of the bullet track through a lung. It is seldom a clean-cut puncture. Usually it is an irregularly walled channel surrounded by lacerated and hæmorrhagic tissue. The amount of possible hæmorrhage from such a wound of the lung will depend to a large extent on gross mechanical factors such as the patency of the channel, the size of the injured vessels, and the distance of these injured vessels from the free pleural surface of the lung. Shell fragment or shrapnel bullet produce exactly the same pathological changes as those which are seen from a short-range rifle bullet, but in greatly enhanced degree. Whatever the penetrating missile had been, the wound of the lung in almost all cases was seen to be of such a nature that bleeding might have been expected to occur from it; and in several examples proof of hæmorrhage was actually found at autopsy in the presence of a plug of blood clot which filled up the hole and hung out from it into the pleural cavity.

That the hæmorrhage from an intercostal artery may be very brisk and difficult to arrest is a matter of common knowledge to the surgeon and to such as have had occasion to experiment on animals. To seek absolute proof of damage to intercostal vessels

[1] "Surgical Experiences in South Africa, 1899-1900," p. 68.

in fatal thoracic injury, entails in the majority of cases a tedious dissection which is but rarely practicable. It becomes necessary to look for signs of hæmorrhage round the possible source rather than to demonstrate the actual lesion in the vessel. Now the hæmorrhage from an intercostal vessel may take three courses. Firstly, the blood may pass outwards from the thoracic wound to the exterior. Secondly, the bleeding may take place into the tissues of the thoracic wall. Or, lastly, the blood may collect in the pleural cavity. The first of these events is of no significance in the present discussion, and it is with the second and third that we are here concerned.

We have looked for evidence of hæmorrhage into the thoracic wall but have found it only in a small number of cases even where there was an extensive rib damage. We have, therefore, been forced to the conclusion that as a rule hæmorrhage from intercostal vessels into the body wall tends to be speedily arrested if it has no other outlet. On the other hand, it is obvious that if there is severe bleeding from the parietes and if it is to reach the pleural cavity then the opening in the parietal pleura must be sufficiently large and sufficiently favourably placed to allow of the ready passage of blood. The conditions most favourable for the production of a hæmothorax of parietal origin are, therefore, fulfilled where the pleural tear is of sufficient size and where the opening in it is directly subjacent to the intercostal vessel. Two cases in our series illustrate this point extremely well. In one of these, death was a surgical accident, due to intrapleural bleeding from an intercostal artery which was divided in the course of an operation for the relief of an already existing septic hæmothorax; and in the second, death ensued as the result of secondary intrapleural hæmorrhage from a branch of the internal mammary artery. In both these cases there was a clear path for the blood from the injured vessel straight into the pleural cavity. But even where there is this open way into the pleural sac there may be no hæmothorax unless the lung be also injured. In four of our fatal cases the penetrating missile had traversed the lower limits of the pleural sac and had passed below the inferior lung margin. In none of these was there hæmothorax. In each there was found rib damage and in each the path into the pleural sac stood open for the entry of blood from the thoracic wall, so that if these injuries in themselves were the factors requisite for the production of a hæmothorax, intrapleural bleeding ought to have occurred. We have assumed that the reason why it did not occur was because there was no lung wound. This view is supported by the records

of other cases in our series in which the wounds were situated at a slightly higher level than those just mentioned, so that the lung was involved. In these higher level cases a hæmothorax was present. Its occurrence was coincident with damage to the lung, and, we believe, really dependent on it.

These observations convinced us that in the great majority of our seventy-eight cases of hæmothorax the blood had been derived from vessels in the lung, where a lacerated wound was generally demonstrable together with wide extravasation of blood into the lung tissue itself, an extravasation that was of considerable extent in cases examined early after the injury, though its rapid absorption or expectoration made this feature of the wound much less conspicuous in later autopsies. Cases do undeniably occur in which the intrapleural bleeding has come from vessels in the thoracic wall, not only from the larger vessels such as the internal mammary artery, from those in relation to the first rib, or from the great veins at the side of the vertebral column, but also occasionally from the intercostal arteries themselves. But the evidence suggests that the latter are not the most common source. In two cases of our series several ribs in succession were found to have been splintered by a tangential wound, in which the lateral path taken by the missile was very likely to have resulted in the tearing of one intercostal vessel after another. The lung in each of these cases was only superficially injured by the rib splinters, and there was no hæmothorax.

Summary.

(1) This paper analyses the cause of death and findings in 100 consecutive cases of fatal gunshot wounds of the thorax seen at base hospitals of the line of communication in France.

(2) Of these deaths ninety-six were directly caused by septic poisoning. Only four died from hæmorrhage, and three of these were cases of secondary hæmorrhage induced by sepsis.

(3) Bruising and laceration of the lung was found around the wound tract in nearly all the cases. The source of the hæmothorax seemed as a rule to have been from vessels in the lung.

(4) The laceration was not a serious lesion when accompanied by a hæmothorax; but in the absence of the latter it was liable to form the starting point of a septic broncho-pneumonia which being unchecked, since there was no collapse of the lung, spread quickly and proved fatal.

(5) Ordinary lobar pneumonia was never observed on the side of the injured lung, and it was found in the contralateral lung in only three cases out of seventy-eight that had hæmothorax.

A PRELIMINARY NOTE ON THE OCCURRENCE OF PECULIAR "BODIES" OF PROBABLY PROTOZOAN NATURE FREQUENTLY FOUND IN THE STOOLS OF DYSENTERIC PATIENTS.

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No pathologist will deny the extraordinarily difficult and complex nature of the problems presented by a microscopical study of the cells found in the fæces from cases of dysentery in the human subject.

The cells encountered, apart altogether from the fact that they are of several different kinds, are frequently so altered by cytolytic and karyolytic changes that the most remarkable appearances are often presented.

In many instances where the more commonly occuring forms of cell-degeneration are comparatively slight in degree, little difficulty is experienced in placing them in their proper category in suitably fixed and stained film-preparations. But it is in cases where pyknosis, karyorrhexis, vacuolation and similar phenomena characteristic of various stages of degeneration culminating in death of the cells are present, that the protozoologist who believes that he has found "bodies" of extra corporeal origin, finds himself confronted with the greatest difficulty.

It is with a full consciousness of the perplexities which surround this subject that we venture to call the attention of other workers to a series of peculiar cells which have attracted our attention for some time past, and which we are strongly inclined to regard as of protozoan nature.

They have never appealed to us as cells of human origin, and in this opinion we are supported by Major Ferguson, R.A.M.C., who, as Director of the Central Laboratory in which we are working, has had frequent opportunities of seeing our preparations, and also by Lieutenant Bartlett, R.A.M.C., Pathologist, who is making further researches in this subject.

The number, character and disposition of their nuclei—to men-

tion only one feature—leads us to regard these cells as probably representing different phases in the development of a protozoön.

It is, of course, quite impossible at present to offer any outline of the possible life-history of this organism. Our immediate object in writing this note is to induce other protozoologists who are devoting themselves to a microscopical study of the fæces from cases of human dysentery to corroborate the occurrence of these peculiar forms in the hope that additional evidence will soon be forthcoming as to their real nature.

We invite a careful study of the drawings which accompany this short paper and which illustrate most of the varied appearances and contents of this cell-organism. Many of these cells are seen to possess two nuclei of unequal size. These nuclei are extremely definite in structure. Even in fresh films of fæces containing these " bodies " their nuclei are very obvious, but in Zenker-fixed preparations stained by either Heidenhain's or Weigert's iron-hæmatoxylin methods their peculiar structure is strikingly demonstrated. They are absolutely spherical in form, with an extremely fine limiting pellicle of chromatin, to the peripheral interior of which is attached a densely staining sharply circumscribed mass of chromatin, lenticular or crescentic in form. The smaller nucleus possesses essentially the same structure, but in this case the chromatin mass appears to be always of crescent shape. The larger nuclei have a distinct compact karyosome, as shown in figs. 15 and 16; the smaller nuclei also possess karyosomes, which are visible in the same drawings, but in some cases they seem to be absent (see fig. 14). The cell-bodies are either round or oval in shape; the cytoplasm stains beautifully and shows no evidence of degeneration or vacuolation. The number of nuclei varies from one to four. There may be only one large nucleus, or one small nucleus, or there may be two of each, as is well seen in figs. 15 and 16. There is another cell often found associated with the foregoing in the same specimens, but this is of quite a different character. In this cell, the nucleus contains a densely staining spherical karyosome surrounded by a darker halo, as illustrated in figs. 24 and 25. The nucleus is not the same as that of *Amœba limax* where the karyosome is surrounded by a clear refractile zone.

We have seen two of these cells in close juxtaposition, suggesting the occurrence of conjugation.

Another cell which we are quite unable to explain, and which is certainly not a body cell, is seen in fig. 14. This curious cell—

25μ by 18μ—has in its endoplasm a large spherical "body," about 8μ in diameter, with a reticulate interior, and a central irregular mass of chromatin. In close proximity to this are two small rings of chromatin with crescentic masses of chromatin at the periphery.

Another cell of great interest is depicted in fig. 27, and illustrates what might be regarded as a process of schizogony with the formation of five spores, each having a distinct "body" and a mass of chromatin. Fig. 30 shows similar "bodies" lying free.

Again, in the same specimens, we have found oval "bodies" with a thick capsule (40μ by 32μ) the capsule being between 2μ. and 3μ thick, and these are found to be crammed with hundreds of "spores" such as are represented in fig. 28. We think these "spores" bear no relation to the other cells drawn. They belong to an entirely independent organism, and are in our opinion a species of yeast cell.

We have found very commonly in the fæces large cells as depicted in fig. 20 which, from its nuclear character, is, in all probability a connective tissue cell from the submucous layer. The figure shows that these cells are capable of phagocytic action in a wonderful degree; in the one which we have had drawn (fig. 20) we see a large round cell, which is probably a parasite. These macrophages of connective tissue origin, besides ingesting parasites of all kinds, have been often observed to englobe polymorphonuclear leucocytes. Indeed, the phagocytic power of cells found in the mucus and blood passed by dysenteric patients is quite remarkable. This power is chiefly exhibited by these large cells, probably derived from the mucosal connective tissue, which are particularly fond of swallowing polymorphonuclears. The polymorphs, on the other hand, show quite a remarkable power of ingesting red cells, and we have in our possession films in which nearly all the pus cells are literally crammed with red blood corpuscles.

There is still another curious cell found in these cases which is probably the commonest of all. This is represented in figs. 21, 22 and 23. Fig. 21 shows an ingested polymorph lying in a vacuole. There is no visible nucleus at the margin of the ingesting cell, but simply a dense, deeply staining mass of chromatin. Figs. 22 and 23 show two similar cells, but in the vacuoles are to be seen two "bodies"—probably protozoa.

It is quite impossible at present to try and correlate all these remarkable cells, but certain of them strongly suggest that we may have to deal with a protozoön. We hope to be able with

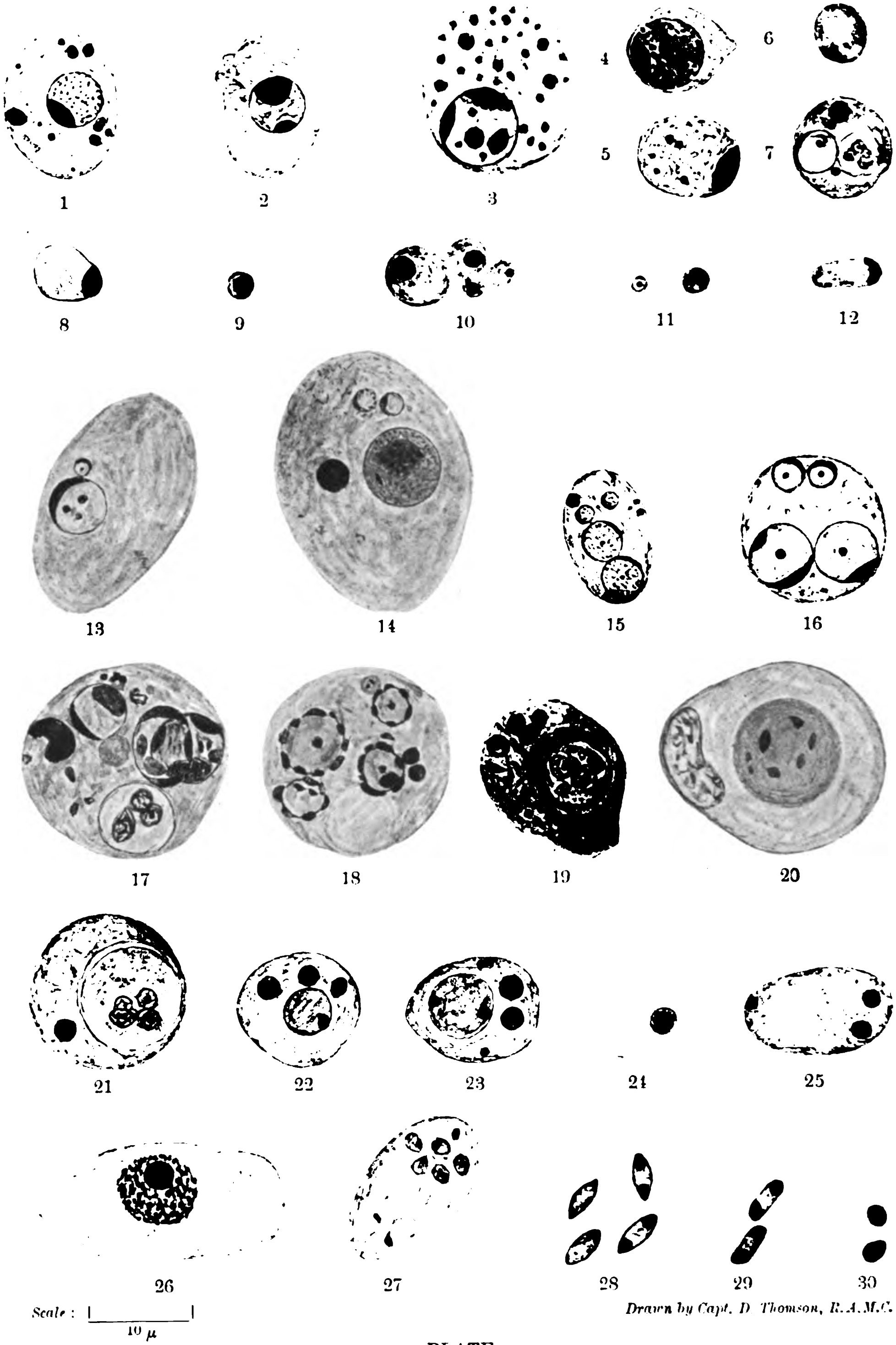

PLATE.

To illustrate "A Preliminary Note on the Occurrence of Peculiar 'Bodies' of probably Protozoan Nature frequently found in the Stools of Dysenteric Patients," by Captain J. GORDON THOMSON, R.A.M.C., and Captain D. THOMSON, R.A.M.C.

further study to throw some light on the significance of these peculiar "bodies." Dr. Bartlett, pathologist to the London Hospital, is making a careful study of these cells.

We may say that we have usually found them in the blood and mucus of dysenteric stools in which it was quite impossible to demonstrate entamœbæ. They are not to be found in all stools of dysenteric cases, but they have occurred with sufficient frequency to entitle them to careful study.

We wish to cordially thank Major Ferguson, R.A.M.C., Director of this Laboratory, for his great help and kindness in assisting in every way in this work; and also Lieutenant Bartlett, R.A.M.C., who has also given most valuable assistance. It was while working with him that the cells were first noticed. It is very interesting to note that these cases recovered after a course of emetine.

DESCRIPTION OF PLATE.

FIG. 1.—Shows a large oval cell with a large circular nucleus. No karyosome is seen and the chromatin is collected into a lenticular mass at one margin. Other chromatin bodies are seen in the endoplasm of the cell-body.

FIG. 2.—Shows a cell similar to that in fig. 1, but this has two masses of chromatin attached to the nuclear membrane.

FIG. 3.—A large cell, with large nucleus, with again the peculiar masses of chromatin on the nuclear membrane. The cytoplasm is filled with dark spherical masses of chromatin.

FIG. 4.—Shows a small cell with a large nucleus.

FIG. 5.—Shows a peculiar "body" with a lenticular mass of chromatin at one margin.

FIG. 6.—Shows a smaller "body" than that in fig. 5, but otherwise resembles it.

FIG. 7.—Shows a cell with the large type of spherical nucleus, and this has ingested a polymorphonuclear leucocyte.

FIGS. 8 and 9.—Shows peculiar "bodies," with chromatin at the margins.

FIG. 10.—Shows a group of rounded "bodies" of unknown significance.

FIGS. 11 and 12.—These show "bodies" of unknown nature.

FIG. 13.—Large cell, with one large nucleus and one small nucleus, both showing the peculiar semilunar arrangement of the chromatin.

FIG. 14.—This shows a curious cell with large circular "body" in endoplasm, and two small circular masses of chromatin near it.

FIG. 15.—An oval cell with four nuclei, arranged in pairs of unequal size, and all showing the characteristic sharply crescentic masses of peripherally arranged chromatin.

FIG. 16.—A larger cell resembling the foregoing but circular in shape with two larger and two smaller nuclei of the same character.

FIG. 17.—A very large cell with three large nuclei and an ingested polymorphonuclear leucocyte.

FIG. 18.—A large spherical cell with four large nuclei, the chromatin in which is broken up into minute peripherally arranged masses. In the upper part of the body of this cell will be observed a round "body" of small size containing two minute dots of chromatin. This little "body" resembles closely the "bodies" drawn in fig. 11.

FIG. 19.—A large cell with a peculiar small circle of chromatin on the left, and showing an ingested polymorphonuclear leucocyte.

FIG. 20.—A large cell with nucleus of the type seen in fibroblasts which contains in a vacuole a spherical "body" of considerable size and probably of protozoan nature.

FIG. 21.—A curious cell, with no evident nucleus, containing a polymorph leucocyte in a vacuole. In the course of our investigations on the protozoa found in the sand of Egypt, we have observed and illustrated forms almost identical with this.

FIG. 22 and 23.—These are probably the same cells as that shown in fig. 21: each contains a rounded body, probably of protozoal nature, in the cytoplasm.

FIGS. 24 and 25.—Cells with nuclei of a different character to those described above. They contain a dense karyosomatic mass surrounded by a dark area.

FIG. 26.—Large elongated cell, with peculiar nucleus.

FIG. 27.—Cell showing bodies strongly suggestive of schizogony.

FIG. 28.—Spores, with bipolar staining, probably yeast cells.

FIG. 29.—Two spores showing peculiar oblique arrangement of dark-staining extremities which are probably yeast cells.

FIG. 30.—Little free "bodies" probably the result of rupture of a cell in which schizogony has occurred, such as is seen in fig. 27.

CONTRIBUTIONS TO THE STUDY OF SHELL SHOCK, BEING AN ACCOUNT OF CERTAIN DISORDERS OF SPEECH, WITH SPECIAL REFERENCE TO THEIR CAUSATION AND THEIR RELATION TO MALINGERING.—IV.[1]

By Temporary Lieutenant-Colonel CHARLES S. MYERS, M.D., Sc.D., F.R.S.
Royal Army Medical Corps.

The principal disturbances of speech which I have observed may be grouped under three heads—aphonia, dysarthria, and mutism. This is the order of frequency in which, from our experience of functional disorders in times of peace, such disturbances of speech might be expected to occur. But in the class of cases with which this War has familiarized us (for reasons which we shall see later), the order is exactly reversed. Dumbness is by far the commonest disorder of speech, occurring in about ten per cent of all cases of shock which have come to my notice; I have met with affections of articulation, e.g., stuttering, or jerky speech, only in about three per cent; while loss of voice, as the result of shock, is of somewhat rarer occurrence.

Mutism.

Immediate Causes.—For the present, the immediate causes of mutism may be most conveniently grouped as—(A) "physical," the patient having been lifted, buried or knocked over by a shell, or having otherwise felt effects (physical or chemical) of its explosion; and (B) "psychical," where, for example, the noise of the shelling has terrified him or a shell has burst near to him, perhaps mutilating several of his comrades. Henceforth I shall, for brevity's sake, allude to cases of mutism by the letters A or B, according to their apparent origin.

The relative frequency of the A and B cases is difficult to determine. Histories are not always easy to obtain: and some cases may belong to both groups, or apparently to A though really to B. But my general impression is that the two groups occur with equal frequency.

Predisposing Conditions.—In about one-third of the cases of

[1] The previous communications on this subject appeared in the *Lancet* of February 13, 1915, January 8, 1916, and March 18, 1916.

mutism various predisposing affections may be demonstrated, e.g., "nervousness," "fits," stuttering, previous shell shock, wound, or exposure to the enemy's gas. These predisposing affections occur as often in the cases of group A as in those of group B.

Mutism is not restricted to any one age. I have met with cases in men of 30, 40, and even 50 years. The average age of the cases of mutism I have seen is about 25 years.

Mutism is extremely rare among commissioned officers. I have heard of one or two cases; but among the many officers I have been asked to see I have not met with one so affected.

Immediate Effects.—The usual direct result of the shock, as described to me by mute patients, is "loss of consciousness" or "loss of memory." I have seen only three cases in which complete preservation of memory was claimed; two of these were highly "nervous" subjects, of whom one had stammered formerly and the other had been subject to fits in childhood. It was of course difficult to decide whether a given patient had suffered from unconsciousness or merely from amnesia, when I saw him after he had "come to himself"; but where, on the one hand, his conditions appeared to have resulted from physical violence, or where, on the other hand, he had been able to walk down with assistance from the trenches, or had been affected with automatism (fugues), or was still preoccupied with the visual or auditory hallucinations of coming shells, a tolerably reliable decision seemed possible.

Both loss of consciousness and loss of memory occur alike in groups A and B; but, as we should expect, unconsciousness appears to be commoner in group A, and amnesia in group B. I have little doubt that the amnesia complained of is almost always due to the onset of a semi-stuporose state, and that many cases of initial loss of consciousness are really the expression of, or at all events subsequently pass into a condition of stupor.

Stupor.—Indeed, a definite history of stupor is obtainable in a very large number of mute patients. Others were still in that condition at the time of my examination of them, staring vacantly into space and taking no notice of their surroundings.

Stupor is apparently commoner in the B than in the A cases, but it does not seem specially prone to occur among those predisposed to shock.

Of the varieties of stupor a detailed description may be deferred until I come to deal with this condition at some later date. But I may note that in this communication I have not classed a man as

mute until his stuporose state has so far passed off that he is clearly capable of observing and reacting to his environment, being able to write or at least to gesticulate.

Onset of Mutism.—As regards the speed and mode of the onset of mutism my records are unsatisfactory, no reliable information being usually obtainable on these points from the patients or from the medical officers of regiments or field ambulances. Most of the patients claim to have found themselves mute on "coming to." That is to say, their functional condition is "of unconscious origin"; whereas in the cases of mutism in which no loss of memory occurs it is probably "of conscious origin."

The following is a typical history given (in writing) by an A case: "A shell burst about two yards away. It lifted me up in the air. I don't know what happened afterwards. [When I came to myself] I was watching the trench mortars coming over and killing my mates and I could not tell them [what was the matter] because I couldn't speak."

The following is an equally typical history of a B case, obtained from the patient's regimental medical officer. "It appears that he was in the trenches at —— where he was subjected to heavy shelling one day. Several burst near him, one blowing in the dug-out and wounding several men. They were relieved two nights or so later, and went into billets at ——. Whilst in a courtyard outside his billet, a shell exploded in the yard and wounded several men, but he was not blown up in any way. He then cleared out to the billet of the other company. Here he was quite dazed, would answer no questions, and if any one came near him he would either jump at them or draw away."

In only a few cases was the onset gradual or late (see, for example Cases 19 and 20, described below).

I have had many opportunities of seeing cases of mutism at field ambulances and clearing stations, that is within a very short time after the occurrence of the shock. They differ usually from those which I have seen (in far greater numbers) at the base hospitals—(*a*) in being more completely mute, (*b*) in being more intensely preoccupied and more intolerant of suggestion. For example, one man, admitted as deaf-mute into a field ambulance, could be induced, when hypnotized, to react to my spoken order (viz., to put out his tongue), but thereupon he awoke and seemed as deaf and as "stupid" as before. Another mute, seen at a clearing station, could be made by post-hypnotic suggestion to pronounce his regimental number, but was found an hour later to

be as completely mute, dazed, and dismal as on admission. A third mute was so preoccupied with thoughts and hallucinations of the shelling that it was quite impossible to obtain his attention for more than a few seconds continuously.

Degrees of Mutism.—As I have just said, many of the men, seen soon after onset, were absolutely dumb. Most of these, however, whom I saw later, could be speedily induced to whisper consonantal sounds and sometimes vowels, while a few had so far progressed as to be able, with encouragement, to repeat in a whisper single monosyllabic words, or even to reply (almost always monosyllabically) to questions.

On the other hand, certain cases, including a few which I believe to have been partially malingering, stolidly maintained an absolute mutism when evacuated to England. I have not seen a case in which meaningless jargon was uttered. With very few exceptions mutes could be induced to cough. Whistling or forcible expiration was often impossible.

Deafness.—A considerable number of mutes give a history of initial deafness. Deafness is as common in the A as in the B group. In many cases it is clearly due to inattention, being part of the vacant, semi-stuporose, or pre-occupied condition of the patient. Such men can occasionally be made to hear but fail to appreciate what is said to them. In others, especially in the A cases, the deafness appears due to diminished sensory acuity. Certain deaf-mutes, nearly all of them B cases, can be made to give an involuntary start on first hearing an unexpected noise, but not again; or they can be induced to carry out the first order addressed to them (e.g., to put out the tongue), but no subsequent order. This condition is generally associated with one of stolid stupidity, combined with complete mutism.

Other Concomitants of Mutism.—Stupor (with the defects which may be considered as part of this condition), amnesia and deafness are by far the commonest concomitants of mutism. Besides these, the following affections may be mentioned, in their order of frequency: muscular tremor, contracted visual fields, unsteady or inco-ordinated movements, defective cutaneous sensibility. I have not seen a case of functional hemiplegia or of hyperæsthesia associated with mutism. I have seen several showing choreiform, spasmodic or "jumpy" movements at an early stage, in some of which, I believe, mutism developed from a previous stage of dysarthria. A very few cases give a history of vomiting. The pulse, when altered, is usually quickened and weakened. The

patellar reflex is often exaggerated; it may be normal, but I have not seen a case of mutism in which it is feeble. I have not examined the palatal reflex in many cases, but I have never found it absent in mute patients. The superficial reflexes of the abdomen and sole are often difficult or impossible to obtain. In a few of the severe cases, fugues or hysterical fits occur at the outset; in other severe cases, voluntary movements are slow, and handwriting is accomplished with difficulty; but, as a rule, writing is easy and the mute patient is eager to describe on paper his experiences—as far as he can recollect them—ending typically with the expression of a wish that he may soon regain his speech.

Experiences of Mutes when trying to Speak.—In fully twenty-five per cent of the cases, reference is made by the patient to discomfort or pain in the throat, the complaint being that "with each attempt something grips me at the sides of the neck," that "My throat is sore," "tickles," or "pains"; a few refer to inability to move the tongue freely (although they can nearly always protrude it), "Something holding my tongue at the back," "My tongue seems to stick," "It curls up at the tip," etc. Now and again this had occurred during the mental strain just preceding the final breakdown.

Some patients make the most violent grimaces on attempting to imitate the sounds of consonants. Not infrequently, they complain of headache, "drumming in the head," or "dizziness," when they try to talk. One of my cases remarked, "I seem silly when I try to talk"; since wounded previously he had been subject to hysterical fits. I have not met with any instances of paralysis of the parts concerned in articulation, although not infrequently the movements are restricted or clumsily executed.

Recovery from Mutism.—In over seventy-five per cent of the mute patients I have seen, their improvement was rapid, the B cases (especially those whom I knew to have passed through a stage of stupor and to be free from any suspicion of malingering, whose mutism was "of unconscious origin") recovering much more rapidly than the A cases. The majority were cured by simple encouragement, persuasion and suggestion, aided or unaided by hypnosis; some were cured by an anæsthetic, a few recovered their speech spontaneously, and a few did so after being harshly reprimanded and isolated from other patients. One patient began to speak spontaneously six hours after the administration of chloroform had failed to effect a cure. A small proportion (about twenty-four per cent) of the cases were unavoidably sent mute to England, where no doubt they have all since recovered.

When speech returns after mutism, it is often laboured or hesitating, more rarely whispered or stuttering, but these defects almost always disappear rapidly. Sometimes the voice is temporarily altered in character, one patient, for example, not recognizing it as his own for a few days.

Those who recover spontaneously do so either on waking from sleep or through some unusually powerful or sudden motive for verbal expression. Such cases have often been previously heard to talk in their sleep.

In curing mutism by persuasion, I have found the following to be a successful procedure. In the first place, I assure the patient that I have already cured many cases of loss of speech by the method I am about to adopt in his case. Next, I ask him each time to copy me as I successively make the sounds (not the accompanying vowels) of B, D, and finally of F, S, K. In by far the majority of my cases I have soon been able to induce the patient to make the necessary movements of the lips, tongue or throat for the production of these sounds. Then I encourage the patient thus: "You see you are beginning to talk. Now let me hear you cough." After he has done so I say, "You see you are able to make a noise." I want you next to cough out an A (continental pronunciation)." After a few trials, the patient is usually able to add this vowel to the end of his cough, whereupon I proceed to teach him other vowels, finally prefixing a consonant instead of a cough to the vowel, and making him vocalize Ba, Di, So, etc. By this time he is delighted with and assured of his progress toward recovery, and it is comparatively easy to get him to combine monosyllables together so that he can repeat after me his surname and regimental number.

The employment of an anæsthetic was first suggested to me by Captain E. T. C. Milligan, R.A.M.C., who had successfully used it at a clearing station. Recovery should be expected during the stage of excitement preceding true anæsthesia. I remember one patient who began to speak after he had had only two or three "whiffs" of chloroform. I have already mentioned another in which recovery occurred some hours after the administration of the anæsthetic. These cases are instances in which the excitement occasioned by the procedure proved in itself an adequate stimulus. On the other hand, I have anæsthetized some mute patients who have passed into a condition of deep anæsthesia without becoming excited, and did not subsequently regain their speech, despite strong verbal suggestion, face-slapping, skin-pinching, etc., applied before

the complete loss and during the recovery of consciousness. I have also met with cases in which, although speech returned during the stage of excitement, a relapse to mutism occurred when the effects of the anæsthetic had passed away.

Where suggestion and encouragement are only imperfectly successful, a complete cure may often be made by recourse to hypnosis. The following cases may be cited as examples :—

Case 17 (Case Number 575).—Serjeant (actually), aged 18, with nineteen months' service, and eleven months' service in France, seen by me on admission to a clearing station to which he had been transferred after three days' stay in another clearing station. The latter clearing station was situated in the town of B—— near the front, and the officer in charge transferred the patient with the following particulars: "On the day of admission he was found in the streets of B—— asking his way to the fire trench. Could not be got to speak on admission, nor since; seems deaf, but now writes rationally."

On admission to the second clearing station, he was at first quite mute and very deaf, but his deafness at once improved on my talking encouragingly to him, and I could soon induce him to cough and to utter the sounds of D, B, F, S, and gradually to whisper, very imperfectly, his name, regimental number, etc. He could write fluently, and wrote that he had no recollection of what had happened to him after being buried, until he found himself at the cross roads in B—— asking the way of a military policeman. Then he "lost" himself again and remembered no more until he had been forty-eight hours in the clearing station at B——.

He complained that when he tried to speak his throat hurt as if it were pulled down, and that when he tried to recall the past his head ached. He was very tremulous, especially in the right arm.

He was then taken into a quieter adjoining room, where his tremors at once increased and he became greatly agitated. But I was able to allay his very obvious fears by suggestions of a cure and by encouragement, and ultimately I induced a mildly hypnotic state in which for the first time he began to speak aloud, at the outset with hesitation, but later fluently. He claimed to have no memory of what had happened after being buried (on the night before his arrival at B——), where he was alone in the dark with his telephone wires. Then after persuasion he began to remember that when he had extricated himself, he ran, as he thought, towards the fire trench, but taking the wrong direction, he found no one in it. Giddy, terrified and in pain (he had been buried by three feet of earth), he found his way to a road, by which time he was scarcely able to walk. He remembered that he met a Frenchman who helped him to his cottage, gave him eggs and bread, and allowed him to sleep on a couch, putting him on a cart at dawn, and driving him "a long way" to the outskirts of B——. At B—— he could hardly see owing to extreme

"giddiness," when he spoke to the policeman. He said that he was "terribly shaken" by the shell (a "coal-box") and still more so when he found the fire trench empty.

I gave him suggestions that, on waking, his headache (already dissipated by suggestion during hypnosis) would not recur, and that on returning to the ward from which he had been brought he would shake hands with the orderly and tell him how glad he was to be well again (which he did without knowing why). On waking, he was delighted at his recovery and talked in a good loud voice, perhaps at first a little hesitatingly. His face, previously clay-coloured, had assumed its normal aspect and he looked, as the orderly well said, "another man."

He had a good night's sleep and was evacuated the next day to a base hospital and thence to a hospital in England, from which he wrote sixteen days later, of his own accord, to thank me for the successful treatment he had received, adding, that save for a shakiness of his hands he was nearly well and hoped soon to be fit for light duty.

Six weeks afterwards, he wrote me that he was very dizzy and unsteady, that he had never previously met with men who had lost their speech, had never been afraid of losing his speech, had never stammered as a child, and had "always been possessed of good nerves." He could now recall nothing after being brought to B—— by the Frenchman until he found himself at the second clearing station. He remembered, however, losing his way in the front lines, wandering into the listening sap, where he found himself "in front of the Hun's barbed wire," and having "a bit of a tustle with three of them at close quarters," on his way back from where he was buried.

Case 18 (Case Number 422).—Private, aged 21, with fourteen months' service and seven months' service in France, seen by me the day after admission to a base hospital, suffering from mutism of over six weeks' standing. His regiment had been heavily shelled, when in support during an important attack. He did not go into the fighting line, but the severe shelling upset him. "My nerves got the better of me; I cried, and my speech got worse and worse." He was taken down to the first-aid post, where and at the field ambulance he could speak a little, but after that he rapidly became quite mute. He had since spent over five weeks at a convalescent camp, where, despite "motor drives, frights and promises" he made no progress. He worked well at the camp and was then sent to work at the base, where he was transferred to a base hospital.

He was in an extremely nervous state when I saw him, breathing very rapidly, but with a not very rapid pulse rate (of 90). He could be induced to cough and soon imitated vowels and the noise of consonants, but could not successfully combine vowel and consonant sounds. He showed no defects of sensibility; visual fields normal. Pupils large, react-

ing poorly to light. No nystagmus. Conjunctival reflex feeble; corneal and palatal reflexes normal. Knee-jerks brisk. Other reflexes not examined.

Two days later he had improved considerably. He told me that he always used to stutter when excited, and was always nervous, so much so that his mother had induced him to give up his serjeant's stripes as he was not expected to be fit for a responsible position under fire.

The next day, under hypnosis, he was able to talk far better. He told me more about his experiences of which he had before been very "hazy," and could be made to repeat "Peter Piper picked a peck of pickled peppers" with fair speed and accuracy. His voice, however, had a peculiar droning monotonous character.

He was sent to England, and a month later was discharged from hospital there. Two months after this, he wrote me: "My speech has improved greatly and it is only when any one in authority speaks to me I seem to lose control of myself and I start and stammer, but I hope soon to be able to conquer both my nerves and my speech. It is very dreary here (in a depot), but I hope to progress better when I get back to my unit."

By written suggestions I have hypnotized a few cases of deaf-mutism, but in only one case have I succeeded in dispelling the deafness during hypnosis. The patient however awoke immediately, mute and again deaf. I have had some promising success by employing lip-reading. But my experience is that until their deafness has disappeared (which occurs in course of time) it is generally useless to attempt to cure mutism in such patients.

The recovery of speech often causes great excitement in the patient, and may even induce a hysterical crisis as in the following case:—

Case 19 (Case Number 158).—Private ——, aged 28, seen by me on admission to a base hospital, suffering from deaf-mutism. He wrote: "I was standing and a shell bursted and that is all I can remember." He thought it had occurred at R——, six days previously, and wrote vaguely about a walk (date unknown) from H—— to "Windy Corner" where he was billeted in a dug-out, about a train journey, and about being in another hospital at C——. He was found to be quite deaf, and very deficient in sensibility to superficial or deep pain and to light touch, especially on his left arm and on the left side of his face. He complained of severe headache. No limitation of visual fields. Movements normal.

Two days later his condition was unchanged, but he distinctly started when I clapped my hands while he was occupied writing for me. The next time I clapped there was no response. I wrote down "Imitate me." I began by making the sounds of consonants, which at length he succeeded in imitating fairly well. Then I uttered the sound A

(continental pronunciation), which he reproduced as Ba; and other syllables, separately and in combination, which he repeated correctly. "You hear me a little now," I wrote; "is this the first time you have spoken ?" He wrote in reply, "I hope the Lord I can get my speech." "But you *did* speak to me just now," I urged. "Read this word, say it," I wrote, showing him his written name (of two syllables.) I also got him to say his number. His speech was slow and rather stammering, but he still appeared not to realize that he had recovered his speech. I was proceeding to convince him that he could now speak and hear me, when suddenly he stretched out his arms and was seized with convulsions, the limb movements being for the most part clonic, with the back arched, and the eyes at first staring, later upturned. Reaching towards the locker beside his bed, he pulled out a crucifix which he held at arm's length and regarded with an ecstatic gaze. Pulse 85, corneal reflex active throughout. At length, after about three minutes, he became quieter and although still very agitated could be induced to talk. His first words on recovery from the attack were about his wife. Then he told me that he had been "seeing a farm and all the fighting." He thought that a shell must have come in then. He had also "seen the Lord who saved" him. He could not recollect having seen me before, but the faces of his neighbours in the ward seemed familiar to me. At first he insisted that he was still at the farm, and every now and again he tended to pass again into a convulsive state. He complained of intense headache and thirst, and later explained that his excitement was due to his recovery of speech.

On the following day he told me that he had no recollection of my trying to get back his speech, and that he could not recall seeing me before he came to himself. "It was just like a dream when I came to. I was sweating awful. I was seeing the Lord while I was in the farm by the Captain. I dreamed that I had the Cross in my hand to meet Him coming. I saw the trenches and the dug-outs and the wife." He remembered that at the farm where he had been with trench mortars he had gone to see his Captain whose arm had just been blown off. He found him lying on the straw unconscious. He came to himself, he said, on a stretcher at a dressing table. Under hypnosis I was able to get little additional information. From the farm he appeared to have gone to a dug-out. He believed that at the clearing station he was "raving, seeing things, shells, trenches, and things like that, sir." He had a vague recollection of the train journey to the base, and his admission to the hospital here.

He was evacuated to England, where he made a slow recovery. He returned to the front seven months later.

Conditions determining Recovery from Mutism.—The youngest patients appeared to regain their speech rather less rapidly than

the oldest. The B cases recovered more readily than the A cases, the predisposed rather more readily than those not predisposed, the stuporose cases more readily than those in which stupor had not been observed, in certain of which some grade of malingering doubtless played a part.

The methods of treating mutism which I have described may be broadly described as "psycho-therapeutic." For a successful issue they should be employed neither too soon nor too late after the onset of the condition. The obstinate cases of which one receives accounts from England are no doubt partly due to the absence, or ineffectiveness, of earlier treatment, which has thus allowed the processes of inhibition at work to become systematized into a habit difficult to cure. I have already pointed out the difficulties of dispelling mutism by suggestion too soon after the shock. The same holds for the tactless administration of an anæsthetic. I remember a case of shell shock admitted immediately after onset into a casualty clearing station in a maniacal condition. Two days later he had become quite quiet and had written an intelligent history of his condition, but was mute. An anæsthetic was given and he spoke while under its influence, but not subsequently. Two days after this an anæsthetic was again given. As before, when "going under" he swore and shouted loudly about British pluck and the Germans. But on discontinuing the anæsthetic, he passed into a deep sleep from which it was impossible to rouse him. A few more whiffs of the anæsthetic were then given, and the words "German shells" were uttered in his ear. He was immediately seized with the most violent convulsions, which rapidly passed into powerful efforts to get out of bed and to fight the imaginary Germans. Five men could hardly restrain him. Ultimately he sank back exhausted, assuming his previous condition of almost complete mutism.

After-history of Mute Cases.—Of twelve cases of which I obtained some after-history, only one appeared to be doing well with his regiment at the Front; two others whom I returned apparently fit to duty reported sick repeatedly with trivial ailments, until at length they succeeded in coming into hospital again. Of the nine who were transferred to hospital in England (only two of whom were mute on leaving France), two were readmitted to hospital after previous discharge to duty, one collapsing while on guard in England, nine months' after the onset of mutism, the other developing dizziness and fits; three were still unfit for duty after four months; two, though on light duty after three months,

and two, though on duty after seven months' treatment, had not completely recovered from shock. Several of the patients protested that they had "received no treatment" while in England—a complaint condemning the policy of mere rest or *laisser aller* to the exclusion of more active, continuous, persuasive or disciplinary measures.

Causation of Mutism.—The first question of importance is whether there are two forms of mutism—the one due to the effects of actual concussion or gas fumes, the patient having been lifted, buried, knocked over, or otherwise immediately exposed to the explosion of a shell, and the other due to horror from some shocking sight or to terror from the heavy bombardment. There cannot be the slighest hesitation in giving a definite answer to this question.

There is no reason whatever to suppose that whereas mutism in the B cases is due to functional inhibition arising from mental shock, in the A cases it is due to minute hæmorrhages or to gas poisoning.

The A and the B cases present precisely the same features of mutism, just as, when dealing with disorders of cutaneous sensibility, we found they presented similar features of hyperæsthesia and anæsthesia. As would be expected, mutism in the A cases generally proves more severe than in the B cases, and, as we have just seen, the less resistant subjects, e.g., the predisposed patients, are more prone to mutism and more readily recover from it. We may conclude then, that whether mutism occurs as the *apparent* result of physical or of mental shock (i.e., as an A or a B case), it is *actually* always the result of mental (i.e., psycho-physiological) shock.

The next question concerns the relation of mutism to stupor. I am unable to produce evidence that those mutes who have at once been rendered unconscious through fainting or through being buried or lifted by a shell pass into a state of stupor before recovering. But I believe that this was the case in at least the large majority of my patients. Indeed I have only the patient's account that they "lost consciousness." Not a single case has come down to me with an official note of true unconsciousness. There is hence a strong presumption that most, if not all, of the cases of alleged prolonged unconsciousness were really due to stupor. I have thus come to regard mutism as in nearly every instance closely dependent on some form of stupor, mild or severe, momentary or lasting, and as being generally a relic of that condition after it has passed off.

Where, in cases of mutism, loss of consciousness has occurred through the patient being lifted or buried, it is, in my opinion, sooner or later an expression of the most profound stupor in which all cerebral activity is inhibited, save those processes that are essential for the continuance of life. From this stage there is a transition to one of ordinary stupor where, although the patient's intelligence is clearly active, he is still absolutely unresponsive to the external world. The inhibitory processes producing such excommunication may be regarded as protecting the individual against further shock. (So, too, the pain or discomfort in the throat or tongue, or the severe headache, evoked by the mute's efforts to speak, tends to preserve the condition of mutism). As the stupor passes away, what is more natural than that inhibition should disappear last in the case of hearing and speech, the two main channels of intercourse with others? Thus we may account for the surprising frequency of mutism, compared with the other disorders of speech. With few exceptions mutism is a functional disorder "of unconscious origin," whereas aphonia is commonly, and dysarthria occasionally, a functional disorder "of conscious origin."

I have not found any evidence pointing to the necessary dependence of mutism on suggestion. Various *a priori* views are possible. We may argue, in the manner of Babinski, that whatever can be cured by suggestion must have been produced by suggestion. We may suppose that a patient, afflicted with mutism, had previously heard of the likely onset of mutism after shock, or that he had already had some disorder of speech (e.g., stammering) in his forgotten youth, or that, on recovery after being knocked down by a shell, he had spoken to a comrade, amid the din of bombardment, when he could not hear himself talk nor hear what was said to him by others; hence, through suggestion, conscious or unconscious, from within or without—through "auto" or "hetero" suggestion—the onset of mutism.

But stupor, to which, as I have urged, mutism is, as a rule, closely related, is the very antithesis of a state of suggestibility; it is a condition of extreme "auto-fixity," in which the patient is totally impervious to impressions from without. His field of consciousness has been narrowed by the shock in such a manner that, instead of responding easily to suggestion, as happens when a person's attention has been fixed and his field of consciousness narrowed during the process of hypnosis, he is absolutely cut off from the external world, as happens in the state of fixed attention

and narrowed field of consciousness induced through religious ecstasy. For bringing about the latter condition it is perfectly obvious that suggestion plays no part. So, too, it plays no part in producing stupor or mutism, where the patient has undergone a severe mental shock, but has never suggested to himself that he shall lose all contact with and yield no response to his environment.

The tendency, already described, of early cases of mutism to revert to a stuporose state after momentary improvement is another indication of the close relation between mutism and stupor. This relation is further well shown in the following case, which also explains the momentary lapses from deafness in deaf-mutism, to which allusion has already been made.

Case 20 (Case Number 465A).—Stretcher-bearer, seen by me two days after admission to a base hospital. He was a stolid, sulky-looking youth. Although mute, he had been heard to talk in his sleep; he could be induced to write a few words about "shells coming over"; he understood, on admission, what was said to him. "When first I saw him," my notes run, "he puts out his tongue and closes his eyes, and holds out one hand when I ask him to, but gets stupid (as if sulky) when I ask for the other hand. He *will* not hear any more." On the following day he appeared quite deaf. The day after that he was lightly anæsthetized with ether, whereupon his hearing at once returned; he put out his tongue to order, and he began to talk, repeating syllables spoken to him, and counting, to order—one, two, three, etc., as he passed into deeper anæsthesia. On waking, he cried as he was induced to resume his speech, and complained of pains in the head.

Two days after he seemed quite normal, and he admitted to me that he could have spoken on the second day after his admission to the hospital. He attributed his behaviour when I first saw him to the fact that his "eyes and ears began to swim," and that he "felt dizzy." He said that he was "afraid to talk," and that he did not want to be sent back to the trenches. He described to me the severe shelling to which he had been exposed, and said that after the shells had burst he lost consciousness until he awoke in hospital at Y——. By further persuasion I induced him to recall little by little how he had been taken by a corporal to the cellar of a school after the shells had burst in the garden of his billet at Y——. I then asked him what he would like to do. He replied that he had excellent chums at the Front, and had been preparing for a jolly Christmas. "I would rather go back," he said, "but would like a rest here first." He had no home in England, as his uncle, with whom he had worked, was serving now in France. He returned to his unit, where, I am informed by his medical officer, he has been for four months, and is "doing well, . . . and never comes sick."

Mutism and Malingering.—The above case is also valuable for the light it throws on the relation between mutism and malingering. The lad admitted that he could have spoken before he was induced to do so. There is no reason to believe that he was not genuinely mute from the start, and for my own part I do not believe that he was truly malingering at the end. The inhibitory effects of the mental shock were slowly passing off after their onset, and it was only a matter of time until they were overcome altogether. I have met with other patients who, on recovering their speech, told me that a few days before they actually talked they had felt that they would soon be able to do so. Such patients are apt falsely to believe that they have been malingering.

On the other hand, cases occur like the following, in which there is graver doubt as to the absence of malingering.

Case 21 (Case Number 423).—Private, (actually) aged 18¾, with six months' service and four months' service in France, was admitted to a base hospital seven weeks after the onset of mutism. He was a healthy-looking lad of stubborn demeanour, refusing to make any sound or whisper, or even to cough; and a few days after his admission he wrote a note of complaint to the medical officer about his treatment in hospital. He showed no defects of sensation and no other signs of shock. I saw him five days after his admission, and after giving him a stern reprimand, ordered him to be isolated from the other patients in solitary confinement, to be deprived of cigarettes, and to be given milk diet. The very next morning he regained his speech. He attributed his recovery to a dream in which he thought he was at home with his mother who had received the tidings that his two brothers had been killed at the Front. He said that he dreamed that he went off to tell the news to his third brother, but could not speak to him. His brother pressed him to talk and he awoke, sitting up in bed, speaking. When I saw him he was absolutely normal, with no lapse of memory whatever of the events which had preceded the onset of mutism. It had been his first engagement, he said; he had seen for the first time the dead lying about; he became dizzy, thought he fainted, "a chap came along and asked me if I was wounded, but I could not tell him, so he took me down, and a major directed me to a cellar and I slept there." He remembered the various hospitals to which he had been sent, and the convalescent camp in which he had spent five or six weeks as a mute. He was sent back to his unit.

I have since heard about him from his regimental medical officer, who wrote, four months later. "I have since seen Private —— several times at sick parades, complaining of vague and trivial matters such as pains in the legs, pains in the back, and headaches. At his last appearance on sick parade he complained that his varicocele was giving him considerable discomfort."

His healthy appearance and stubborn manner, his absolute mutism and inability to cough, the manner of his recovery, the absence of stupor, amnesia, tremor, or any other signs of shock, certain discrepancies between his written and (later) spoken history, his general behaviour while in hospital and after—all throw grave suspicion on the absolute genuineness of his condition. But none of these can be regarded as certain guides. Functional disorders are apt occasionally to simulate malingering just as at other times they simulate organic lesions. How even the most experienced may be deceived is shown in the following case.

Case 22 (Case Number 450).—Private, aged 26, with one year's service and three months' service in France, admitted into a base hospital for deaf-mutism of nine weeks' standing. He wrote: "I should be very happy if you can do anything for me. I cannot give a very clear account of what happened, as it is some time since. I remember retiring from Hill —— with some more to some trenches and in the open we were shelled and I lost touch with our chaps or else they were killed. I remember a great concussion and finding myself on the ground and a soldier dragged me up and we ran for the trench. I was very thirsty and I ran down the trench to get some water. I met one of our chaps and tried to ask him for some and I could not make him understand. He only smiled at me. The man who picked me up took me to an officer who was sitting on the edge of the trench and tried to make me understand, and then he sent me with this man to a dressing station and from there I have been to different places, the names of which I do not know, except the last place, No. —— Convalescent Camp. I have been there about two months."

He appeared an honest lad, anxious to get well. He wrote that he could hear me, but could not understand what I said. When I whistled he wrote, "I think I can hear a drone." He himself could not whistle, although he "used to whistle as a youngster." He could not protrude his tongue without first pulling down his lips. He could move it from side to side. He was anæsthetized on the following day, but he did not pass through a stage of excitement and failed to regain his speech. He was evacuated to England.

Three months later he wrote me the following "confidential" letter from "a convalescent home" in England. "Sir, I regret very much to have to inform you that I was imposing upon you. I may state that I was physically unfit for the Front. During the whole time of training my pay was chiefly spent in tonics and drugs, but I kept going as I was determined to see what it was like at the Front. I have written this that your 'notes' on cases will not suffer any detrimental effect through my imposture. I have not got my

discharge yet, but shall stick out for it. I 'speak' but do not 'hear' very well." He had been for over six weeks in a certain hospital in England, the medical officers of which have had unique experience in the functional nervous disorders arising in this war, but they inform me that they did not regard him as a malingerer. There he repeated to them the same history as he had given me, and spoke of a previous nervous breakdown and recourse to sulphonal and Easton's syrup. His "hearing somewhat improved, but he has always been a little deaf." Before his departure he could speak, hear a watch and "sometimes hear spoken words." The "convalescent home" (he was careful not to name it) from which he purported to write to me turned out to be another hospital for functional nervous cases to which he was afterwards transferred, the medical officer of which wrote me: "In my opinion this man is not a malingerer. He is very dull and stupid, which perhaps is partly explained by his deafness. His condition appears to me to be one recovering from severe mental shock."

This seems to be an instance of pure malingering. By a pure malingerer I mean one who, although in perfect health, of set purpose initiates a pathological condition which he will discard when he has gained his end or when he is assured that he is unobserved. So far as concerns disorders of speech, such cases are extremely rare in the present war. With few exceptions the "simulators" of disorders of speech who have come to my notice have been feeble nervous subjects themselves. Several have come intentionally to maintain a disorder which was involuntary and functional in origin, and due, perhaps, to suggestion; they are not pure malingerers.

It is a matter of considerable difficulty for even the most experienced medical officer to decide whether the lack of volitional impulse to overcome the disorder is intentional or is for the time being beyond the individual's control. From the therapeutic standpoint, the difficulty is not of great importance, as long as treatment be confined to such procedures as persuasion, isolation, or anæsthesia; by which means I have "cured" several cases of intentional malingering. From the standpoint of military discipline, however, the difficulty becomes of vital importance; and from this standpoint it is to be remembered that although long experience yields a highly probable conclusion, absolute certainty can only be reached by detection *in flagrante delicto*.

In theory we may distinguish (*a*) the stage of mutism which is absolutely irresponsive to treatment, and (*b*) the stage in which recovery is possible if only an adequate motor impulse can be

aroused to overcome the inhibition. And in (*b*) we may distinguish (i) the condition in which the patient is constitutionally unable to make the requisite volitional effort, (ii) the condition in which he refuses to attempt to make that effort, and (iii) the condition in which he deliberately maintains his mutism by counter-availing volitional effort. But in practice every grade of transition may be met with between quite uncontrollable functional disorder and sheer purposeful malingering.

At the pathological extreme of the series are to be seen, clearly enough, cases of true mental shock, and, far less commonly, cases due to suggestion, both of which groups evidently belong to that hitherto undifferentiated entity, hysteria. Now, of hysteria no medically qualified man, unless he be steeped in the profoundest ignorance, would assert that it is identical with, or that it necessarily implies, any of the above-mentioned degrees of malingering. The cases of mental shock that recover their speech in a music hall or at a cinematograph entertainment, or that recover their sight or the movement of their limbs upon receiving another mental shock, clearly need not have been malingerers. It is hardly less obvious that malingering has not necessarily been present in mutes who become cured through suggestion, encouragement, or threats of punishment, or under the excitement of early anæsthesia, by laryngeal faradization, or by the vomiting brought about by the administration of ipecacuanha.

Dysarthria.

The cases of dysarthria with which I have met range from a slight stutter, stammer or jerkiness of speech to almost complete anarthria, according to the degree of disturbance in the correct working of the articulatory mechanism. These cases are almost invariably associated with other motor inco-ordination of a functional character, and in consequence will be more conveniently described in a later communication dealing with disorders of the voluntary muscular system generally.

Aphonia.

Cases of primary aphonia from mental shock, "of unconscious origin," as contrasted with functional aphonia due to suggestion, conscious or unconscious, are in my experience rare. I have seen several cases where the hoarseness originating from a severe cold passed into a functional aphonia which was, subsequently, allowed to persist. I have cured some of these cases by persuasion, and some by such mild torture as pin-pricking, continued until the

patient is induced to give his answers in a loud voice. Usually a feeble, "nervous" fellow, he at length speaks aloud, bursting into tears as he realizes that his simulation has been detected. Malingering plays a far more important factor in this variety of speech defect than in any other. I have met with a few cases of pure malingering. Not infrequently a mute patient begins to whisper when he first recovers his speech. But I have not had a case, in which, by further suggestion, I have failed at once to overcome the obstacle to phonation.

General Conclusions.

The views already expressed in this communication, as to what mutism is due and to what it is not due, are also applicable to dysarthria and aphonia. Such disorders, I repeat, are not attributable to direct violence, gas-poisoning or other physical causes. They are the result of a functional inhibition, which is usually traceable to intense fear or horror, but which may, I believe, occasionally arise in circumstances where consciousness has been so instantaneously lost that the emotional effects of the shock have not been actually experienced by the patient.

These disorders of speech are not to be regarded as the direct outcome of suggestion or association, although, as in the other manifestations of shell shock[1], previous experience or congenital tendencies may influence the form in which the disorder gains expression. In some instances, no doubt, the speech mechanism is a weak spot in the patient's nervous armour. He may have stuttered when a child, he may have been subject to attacks of hoarseness, he may have passed through an abnormally long period of "infancy," he may never have been as ready of speech as most of his fellows—and so on. But though these may be contributing factors, they are not the prime cause of the disorders of speech in shell shock, save in the exceptional cases already mentioned.

Nor are they due to some "fixed idea of paralysis" in the cortical structures controlling voluntary speech. Such terminology belongs to an effete psychology; it has been long in vogue among physicians for the explanation of functional disturbances generally. A woman suffering from hysterical palsy of a leg has been often said to be possessed of a "fixed idea" that she cannot move it. If we insist, "How do you know that she has this fixed idea if she stoutly denies entertaining it and even evinces a keen desire to recover the use of her limb?" the retort comes—"Ah! the idea of

[1] *Cf.*, in the third of my communications, the influence of past history.

paralysis is subconscious; she does not know that she has it, but it is there."

The word "idea," however, necessarily implies the presence of a personality that consciously experiences and admits it. And to speak of the existence of a fixed idea which cannot be proved to be in consciousness under any conditions whatever is a sheer abuse both of psychological language and of scientific method. In the case of the disorders of speech arising from shock, I have never found the slightest evidence that the subject, whether in his normal or in a hypnotic state or in any derived personality, has a "fixed idea" that he is mute or that he is powerless to converse save in a whisper or stuttering.

I have little doubt that this pseudo-psychological explanation proceeds from two sources: (i) from the notion that functional disturbances are invariably due to disordered volition, and (ii) from the notion that, in order to carry out a willed movement, the idea of that movement must necessarily be present to the subject's mind. Neither of these notions is correct. In the first place, one of the most important lessons to be learnt from the study of shock in this war is that its effects are primarily due to disorder, not of the will, but of the conscious and unconscious processes which are the foundation of personality, and that (through mechanisms and causes of which at present we know little) these effects may indirectly become manifest as functional disorders at various levels of the central nervous system. In the second place, modern psychologists have come to recognize that volitional movements may, and commonly are, performed without the subject having in consciousness an idea, or even a kinæsthetic image, of those movements.

It is, then, not the idea of paralysis of volition that is fixed but the psycho-pathological process of inhibition. Inhibition, arising primarily from disorder within the personality, is the fundamental cause of the effects of shell-shock.

Now, in dealing with the disturbances of cutaneous sensibility (in the third of these communications), we saw that the responsible inhibitory processes are of two kinds. On the one hand, we traced *diminished* sensibility to a blocking of the ascending paths which normally enable the subject to become aware of his cutaneous sensations; the block preventing these sensations from entering into and becoming part of his personality. On the other hand, we traced *increased* sensibility to a blocking of the descending paths that control normal sensibility; in the absence of which control, cutaneous sensations become more diffuse and the affective and

sensori-motor reactions more intense. In the case of the disorders of speech, two similar kinds of inhibition are discernible—the one due to a blocking of the paths that subserve the mechanism of articulation or phonation, the block producing the *quasi*-paralysis of functional mutism or aphonia, the other due to a blocking of the paths that control those mechanisms, the block producing the *quasi*-spastic-clonic or ataxic conditions of functional dysarthria.

In some cases of mutism the block yields a condition to some extent comparable to a so-called "kinæsthetic apraxia." The patient appears to lack all notion of how to talk, to whistle or to cough. Instead, he makes extraordinary grimaces, his mouth often continuing to work long after he is actually endeavouring to imitate a given word. It may be called a state of functional motor aphasia; and it is due, like that of organic motor aphasia, to an inability to translate normally produced internal language into the corresponding movement. In both forms the patient may read and write intelligently, but the functional form may differ from the organic in that in the former speech may be completely absent, whereas in the latter the patient is occasionally able to utter a few words normally articulated.

In other cases of mutism the inhibition is of a higher order, and it results in a state comparable to an "ideational apraxia," in which the subject can perform simple articulatory movements but is powerless to combine them into the movement complexes of speech. Thus I have seen patients well able to reproduce consonants and vowels, but yet unable to unite them into a syllable or word.

In other cases again, the inhibition produces a state resembling "verbal agnosia," in which the patient has forgotten the meaning of words heard or read. Such cases have not been included in this communication, as they may be more conveniently considered under the head of amnesia. They differ from those of organic verbal amnesia in that the disturbance does not necessarily relate to all words and so does not result in a total verbal apraxia.

Lastly, the areas inhibited may spread still wider or higher, producing partial or complete amusia, alexia or agraphia, or narrowing the field of consciousness to a condition of general amnesia in which the patient has lost all memory of the past, or to one of stupor in which he has lost all power of response to his environment.

In every case the inhibition is purely functional, dependent on the character of the total psychosis, i.e., the personality of the subject, at any given moment. That personality may be changed again in sleep, under light anæsthesia, during hypnosis or through

strong emotion or desire; and in these conditions the inhibitory process, and hence the disturbances of speech, may disappear, only to return on the revival of the disordered personality. The inhibitions caused by shock are primarily the expression of disordered personality.

Such disturbances of speech, such inhibitions are not, as has been urged, maintained by fear, nor need they be evoked by fear. They may be evoked by various other emotions, by horror, grief, disappointment, anxiety, or they may be due merely to the (unknown) neuro-pathological concomitants of shock (the dangerously vague expression *commotio cerebri* is to be avoided) when no emotion, as such, has the opportunity of being experienced; and they are maintained by the persistence, not of the emotion, but of the pathological disorder of inhibition thus arising, which may continue even after the restoration of the normal personality.

It may be objected that the inhibition often seems to outlast the return of the normal personality. But the claim may be fairly put forward that when a mute patient has recovered from a condition of stupor and is still amnesic in regard to some of the experiences through which he has passed, the restoration of his normal personality is apparent rather than real. If personality be viewed from a wide enough standpoint, no one can claim to have a normal self, so long as part of the activities of that self, once functional, are pathologically inhibited.

It must be conceded then that, as in most cases of mutism, the change of personality may be obvious at the outset (involving amnesia, stupor, automatism, etc.), but that later the normal personality may be apparently—but only apparently—restored while the functional disorder in some form persists. In such cases, as we have seen, the disorder is usually of unconscious origin, due directly to the shock, and may occur in men free from suspicion of prior neuropathic taint.

It must also be conceded that, as in a few cases of mutism and as in nearly all cases of aphonia, the change of personality may be imperceptible from the outset. In such cases the disorder is usually of conscious origin, due to suggestion or the expression of a powerful emotion (e.g., mutism during fright), and it occurs in men of a neurotic temperament.

Into these two classes, I suggest, all cases of shell shock or of functional or hysterical disorder may be divided. But it must be recognized that neither between these two classes, nor between the second class and the class of malingerers, is it possible to draw any definite line.

THE DISTRIBUTION OF TYPHOID AND PARATYPHOID INFECTION AMONGST ENTERIC FEVERS AT MUDROS, OCTOBER TO DECEMBER, 1915.

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The early records from France of the incidence of enteric fever upon inoculated and uninoculated British troops showed no significant difference. This was in contrast with results previously obtained, and notably with those patiently collected over the years 1905 to 1908, by the War Office Committee appointed to examine into the virtues of anti-typhoid inoculation, according to whose report the incidence was about 1 to 9 respectively.[1]

This discrepancy might obviously be accounted for, if the prevailing type of enteric infection was not typhoid but paratyphoid, for Kabeshima[2] has shown that inoculation against typhoid affords no protection against paratyphoid A or B. Accordingly, endeavours were made towards the end of 1914 to differentiate these latter fevers from typhoid.

Early in 1915, Dreyer, Walker and Gibson[3] published the results of the examination of a limited series of cases at the base hospital at Oxford. They concluded that no case of typhoid fever had occurred in the inoculated individuals of their series, and that, as found by Kabeshima, paratyphoid fevers had occurred with equal frequency among anti-typhoid inoculated and non-inoculated individuals. Dreyer, Walker and Gibson (*loc. cit.*) were of opinion that the cases returned as typhoid fever amongst our troops were to a large extent paratyphoidal infections.

A large portion of our work at No. 3 Australian General Hospital at Lemnos consisted in helping our medical colleagues

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[1] Leishman, Colonel W. B. "Statistical Results of Anti-typhoid Inoculation," Journal of the Royal Army Medical Corps, xii, p. 168. 1909.

[2] Kabeshima T. "Ueber Typhus und Paratyphus Schutzimpfung, usw., in der kaiserlich. Japanischen Marine." *Centralblatt für Bakteriologie*, Originale Band 74, p. 294. 1914.

[3] Dreyer, G., Walker, E. W. A., and Gibson, A. G. "Typhoid and Paratyphoid Infection in relation to Anti-typhoid Inoculation." *Lancet*, February 13, 1915.

to arrive at an accurate diagnosis of the various intestinal diseases, which bulked so largely in the medical practice of the hospital. To this end, in the case of the enteric fevers, we chose the serological method as our routine procedure. It would not have been possible, with the material and assistance at our disposal, to have made more than one-fifth the number of observations by blood culture, and at least half of these would have miscarried, as so many of the patients were past the first week of the disease on admission.

We were aware that the interpretation of agglutination results would, in the case of persons inoculated against typhoid, be a matter of some difficulty; but we had the advantage of working in close co-operation with our physicians, who kept us in touch with the subsequent history of the patients so that repeated observations could be made if desirable. We therefore hoped, that in the great majority of cases, any ambiguity might be removed.

There is no one perfect method for estimating the distribution of the various enteric infections. Conclusions drawn from blood cultures alone are not free from error, for the proportion of successful cultivation is higher in typhoid than in paratyphoid B fever.

During the three months October to December, 1915, we gathered a considerable amount of data which we shall proceed to deal with, in view of its bearing upon the distribution of enteric fevers at Gallipoli during this part of the campaign.

In carrying out the agglutinations we had from time to time valuable help from Sister Williams and Captains Bahr, Brennan and Maclure. In scrutinizing the cases whose sera gave an agglutination to typhoid only, the importance of which scrutiny will be emphasized below, we had invaluable help from Lieutenant-Colonel Stawell, Lieutenant-Colonel de Crespigny and Captain Ercole. To one and all we express our deep sense of gratitude.

Method employed in Detail.

The emulsions were, in the first instance, made from strains of typhoid, paratyphoid A and paratyphoid B bacilli obtained from the Lister Institute. The first is a readily agglutinable strain which has been propagated in the laboratory for several years. The two last are descendants of Schottmüller's original strains. Subsequently we substituted a locally isolated strain of *B. paratyphosus* B, as the Schottmüller strain did not form good emulsions. The bacilli were grown for twelve hours on nutrient agar, emulsified in saline by gently agitating the bottles and diluted so as to show

definite opalescence when placed in the tubes used for the agglutinations, which were about ¼ inch in diameter. Formalin was added to make a concentration of 0·1 per cent. Each brew of emulsion was tested against standard sera obtained from the Lister Institute, which agglutinated all three emulsions up to a dilution of 1 in 16,000. The agglutination was specific in a dilution of 1 in 50. Lower dilutions were not tried. As fresh emulsions were made from time to time, they were tested in the same way against the corresponding standard serum. No significant variation in agglutinability was observed during the course of the observations.

About a fifth of a cubic centimetre of blood was drawn from the patient into a sterile glass pipette and sealed. The blood serum was usually separated from the clot by centrifuging on the same day. For diluting the serum, pipettes drawn out in the flame and cut off at a point where their orifice had an external diameter of 1·12 millimetre were employed. Such a pipette drops 0·02 cubic centimetre of serum if held vertically. Two drops made up to one cubic centimetre affords a dilution of 1 in 25. For arranging the series of dilutions we used pipettes drawn so as to leave a small bulb intervening between the two capillary portions (fig. 1), which latter should have thick walls.

The contents of the pipette is arranged so as to equal about half the volume it is desired to work with in the agglutination tubes. The exact content is not material if the same pipette is used throughout the series of dilutions and subsequently for adding the emulsions. For convenience, however, we made two stock sizes of pipettes which contained 0·15 cubic centimetre and 0·25 cubic centimetre respectively. The pipettes in each series were then interchangeable.

The successive dilutions were made by the usual method, viz.: Two volumes of the first dilution of serum were placed in tube No. 1 of the series, and into tubes 2, 3, 4, etc., was placed one volume of water. Thereafter, one volume was removed from tube No. 1, emptied into tube No. 2 and mixed. A volume of this mixture was withdrawn and emptied into No. 3 and mixed. One volume withdrawn from No. 3 was emptied into No. 4, mixed, and so on until the last tube of the series was reached, when, after mixing, the one volume removed was discarded. In this way, each

successive tube contained serum twice as dilute as the previous one. The procedure having been carried out in triplicate, to every tube in each series an equal volume of emulsion of typhoid, paratyphoid A, or paratyphoid B bacilli respectively, was added and the contents mixed. The tubes were placed in the incubator at 37° C. for two hours, allowed to remain on the bench for one hour and the results read.

The following conventional series of marks was awarded and will be employed in this communication :—

Complete agglutination	+++
Agglutination visible to the naked eye	++
Agglutination visible with lens magnifying four diameters ..	+
No agglutination visible with lens magnifying four diameters ..	–

The sera of 350 patients were tested against *B. typhosus*, *B. paratyphosus* A and *B. paratyphosus* B in dilutions of 1 in 100, 1 in 200, 1 in 400 and 1 in 800. In the remainder the 1 in 800 dilution was omitted to save labour as it was found that the results could, in most cases, be equally well read without it. After the first two months a lower dilution, 1 in 50, was employed for the paratyphoid A series, as we found that we were missing some infections due to this organism by beginning at 1 in 100. For reasons which will be entered into later these cases were generally recorded as typhoid.

TABLE I.

No agglutination (minimal dilution of sera 1 in 50 or 1 in 100) ..	163
Agglutination to *B. typhosus*	138
,, ,, *B. paratyphosus* A	66
,, ,, ,, and *B. typhosus*	136
,, ,, ,, *B. typhosus* and *B. paratyphosus* B (last slight or transient)	9
,, ,, ,, and *B. paratyphosus* B (latter slight or transient)	2
,, ,, *B. paratyphosus* B	19
,, ,, ,, ,, and *B. typhosus*	88
,, ,, ,, ,, *B. typhosus* and *B. paratyphosus* A (last slight or transient) ..	5
,, ,, ,, ,, and *B. paratyphosus* A (latter slight or transient)	1
	627

Results.

Observations were made upon the sera of 627 patients and 151 normal persons. As we were functioning as the clinical laboratory of a large general hospital, the patients whose sera we examined were not all enterics. If the medical officer thought that a sera-

logical examination would help him towards a diagnosis, the blood was sent to the laboratory. The 627 patients consequently included a number who were suffering from other febrile diseases.

In Table I below are set forth the gross results.

The Interpretation of Agglutination Findings in Patients, previously Inoculated against Typhoid Fever.

(1) *Agglutination of B. typhosus.*—Dealing, as we were, with a population almost entirely inoculated against typhoid within fourteen months, it is not surprising that 376 out of the 627 should show an agglutination to *B. typhosus* in a dilution of 1 in 100 or upwards.

Before we are able to draw any conclusions from our results, it is first of all necessary to ascertain, following the technique used, the amount of agglutination which occurs from inoculation only. To determine this, the blood of members of the staff and hospital orderlies, who had not been sick, was examined under similar conditions to those employed in the case of patients.

Agglutination Titre for *B. typhosus* of the Sera of seventy-five healthy persons inoculated against Typhoid seven to fourteen months previously.

7 agglutinated	in a dilution of	1 in 800
12 ,,	,, ,,	1 in 400
22 ,,	,, ,,	1 in 200
16 ,,	,, ,,	1 in 100
18 did not agglutinate	,, ,,	1 in 100

That is, two-thirds showed an agglutination titre of 1 in 200 or upwards and in 10 per cent it was 1 in 800 or upwards.

In addition to the above experiment, the pooled sera of twenty-eight men inoculated on the same day fourteen months previously, was found to give a good agglutination at 1 in 200, a result in close agreement with the above.

It follows, therefore, that in an inoculated person an agglutination of *B. typhosus* by his serum up to the limits observed by us in patients, is not necessarily significant of typhoid infection, and that in order to arrive at a diagnosis of typhoid fever in our cases other means must be resorted to.

When we commenced our observations we were under the impression that the progressive development of typhoid agglutinins during the course of illness, reaching sometimes a titre of 1 in 1,000 or upwards, might, in the absence of any discoverable agglutinins to *B. paratyphosus* A or B, be taken as evidence of typhoid fever.

We were strengthened in this belief by the conclusions arrived at by Dreyer, Walker and Gibson (*loc. cit.*), who pointed out, quite rightly, that a differential diagnosis may be arrived at by measuring the agglutination titre to typhoid and paratyphoid bacilli respectively over a period of a few days. This method is, however, beset with pitfalls.

Early in our observations, as we shall proceed to show, it became apparent that many sera agglutinating one of the paratyphoid bacilli simultaneously agglutinated typhoid bacilli to an unexpected degree. Further, in a number of cases of paratyphoid fever in which repeated observations were carried out, a progressive development of typhoid agglutinins preceded by one to two weeks the development of agglutinins to the paratyphoid bacillus. We give below examples illustrating this phenomenon in which paratyphoid bacilli were isolated. Unless the observations had been persisted in, all of these would have been diagnosed as typhoid fever. We ought to have been alert to this possibility, for in 1911 Grattan and Harvey[1] described its occurrence in paratyphoid A fever in India. Attention was also drawn to it by Firth,[2] and later by Safford.[3]

			1 in 100	1 in 200	1 in 400	1 in 800
No. 3729	Before illness.	Ty	+ +	–	–	–
		A	–	–	–	–
		B	–	–	–	–
	After 1 week.	Ty	+ + +	+ + +	+ +	–
		A	–	–	–	–
		B	–	–	–	–
	After 2 weeks.	Agglutination the same. *B. paratyphosus* A was recovered from urine.				
	,, 3 ,,	Agglutination the same.				
	,, 4 ,,	,, ,,				
	,, 5 ,,	Ty	+ + +	+ + +	+	–
		A	+ + +	+ + +	+ + +	+ +
		B	–	–	–	–

B. paratyphosus A was isolated from the fæces in the fourth week.

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[1] Grattan, Major H. W., and Harvey, Major D. "An Inquiry into a small Epidemic of Paratyphoid Fever in a Camp in India," Journal of the Royal Army Medical Corps, 1911, vol. xvi, p. 9.

[2] Firth, Colonel R. H. "Recent facts as to Enteric Inoculation and the Incidence of Enteric and Paratyphoid Fevers in India." Journal of the Royal Army Medical Corps, 1912, xix, p. 157.

[3] Safford, Major A. H. "Paratyphoid Fever, an account of two epidemics, etc." Journal of the Royal Army Medical Corps, 1913, xx, p. 567.

			1 in 100	1 in 200	1 in 400	1 in 800
No. 3681	1st week of illness.	Ty	−	−	−	−
		A	−	−	−	−
		B	−	−	−	−
	3rd week of illness.	Ty	+++	+++	++	+
		A	−	−	−	−
		B	−	−	−	−
	4th week of illness.	Ty	+++	+++	++	+
		A	++	+	−	−
		B	−	−	−	−

B. paratyphosus A was recovered from the sputum and pleural exudate during the third week of illness. The patient died in the fourth week with gangrene of the lung and localized pleurisy. *B. paratyphosus* A was recovered in pure culture from the spleen. The bile was sterile.

			1 in 100	1 in 200	1 in 400	1 in 800
No. 3778	1st week of illness.	Ty	−	−	−	−
		A	−	−	−	−
		B	−	−	−	−
	2nd week of illness.	Ty	++	+	−	−
		A	−	−	−	−
		B	−	−	−	−
	3rd week of illness.	Ty	+++	+++	++	+
		A	+++	+++	+++	+
		B	−	−	−	−

B. paratyphosus A was recovered from the fæces during the third week.

			1 in 100	1 in 200	1 in 400	1 in 800
No. 522	2nd week of illness.	Ty	+++	+	−	−
		A	−	−	−	−
		B	−	−	−	−
	3rd week of illness.	Ty	+++	+++	++	+
		A	−	−	−	−
		B	−	−	−	−
	5th week of illness.	Ty	+++	+++	++	+
		A	−	−	−	−
		B	+++	+++	+++	+++

The patient died in the sixth week of illness. A pure culture of *B. paratyphosus* B was isolated from the spleen and bile. The heart blood taken post mortem agglutinated *B. paratyphosus* B in a dilution of 1 in 10,000.

In the instances detailed above, infection with one of the paratyphoid organisms stimulated the production of typhoid agglutinins early in the disease, and it was not until as late as the third to fifth week that the titre for the infecting organism rose to 1 in 100. This occurred in about two per cent of our cases, all, with one exception, paratyphoid A fever.

As soon as we became aware of these facts we regarded with suspicion the development of typhoid agglutinins in a patient previously inoculated against typhoid fever, and he was only diagnosed as typhoid when *B. typhosus* was isolated, or, being clinically a case of one of the enteric group of fevers, when no evidence of paratyphoid infection could be obtained. Even so, we have reason to believe that some cases of infection with *B. paratyphosus* A were returned as typhoid, for, occasionally, the development of agglutinins to this organism is slight and transient.

In order to throw some further light upon the interpretation of the rise in typhoid agglutinins in paratyphoid infections, we inoculated healthy persons, some of whom had previously received anti-typhoid vaccine, with paratyphoid A and B bacilli. In about half of those who had been previously inoculated this was followed by a considerable development of typhoid agglutinins. The instances given below were amongst the most striking:—

			1 in 100	1 in 200	1 in 400	1 in 800
No. 1001	Inoculated against typhoid six months previously	Ty	−	−	−	−
		A	−	−	−	−
		B	−	−	−	−
	Eleven days after injection of 200 millions *B. paratyphosus* A and 200 millions *B paratyphosus* B	Ty	+++	+++	+++	++
		A	+++	+++	+++	+++
		B	+++	+++	+++	++
No. 1002	Inoculated against typhoid five months previously	Ty	−	−	−	−
		A	−	−	−	−
		B	−	−	−	−
	Ten days after 200 millions each of *B. paratyphosus* A and B	Ty	+++	+++	++	−
		A	+++	+++	+++	+++
		B	++	−	−	−
	Fifteen days after above	Ty	+++	+	−	−
		A	+++	+++	+++	+++
		B	++	−	−	−
No. 1008	Inoculuted against typhoid twelve months previously	Ty	−	−	−	−
		A	−	−	−	−
		B	−	−	−	−
	Seven days after inoculation with 50 millions of each *B. paratyphosus* A and B	Ty	+++	+++	+++	+++
		A	+++	+++	+++	++
		B	+++	++	+	−

No. 1010	Inoculated against typhoid six months previously	Ty	+ +	−	−	−
		A	−	−	−	−
		B	−	−	−	−
	Eleven days after second inoculation with 500 millions of each *B. paratyphosus* A and B	Ty	+ + +	+ + +	+ + +	+ + +
		A	+ + +	+ + +	+ + +	+ + +
		B	+ + +	+ + +	+ +	+
No. 1012	Inoculated against typhoid seven months previously	Ty	+ +	−	−	−
		A	−	−	−	−
		B	−	−	−	−
	Fifteen days after inoculation with 50 millions *B. paratyphosus* A	Ty	+ + +	+ + +	+ + +	+ +
		A	+ + +	+ + +	+ + +	+ + +
		B	−	−	−	−
No. 1013	Non-inoculated.	No agglutination to Ty. A or B in 1 in 100				
	Ten days after inoculation with 200 millions each of *B. paratyphosus* A and B	Ty	−	−	−	−
		A	+ + +	+ + +	+ + +	+ +
		B	+ + +	+ + +	+ +	−
No. 1014	Non-inoculated. Nine days after 200 millions each of *B. paratyphosus* A and B	Ty	−	−	−	−
		A	+ + +	+ + +	+ +	+
		B	+ + +	+ +	−	−
No. 1015	Non-inoculated. Ten days after 250 millions each of *B. paratyphosus* A and B	Ty	−	−	−	−
		A	+ + +	+ + +	+ + +	+ + +
		B	+ +	+	−	−

Harvey and Wood[1] found in the cases of paratyphoid A fever which they studied, that the agglutinins for both *B. typhosus* and *B. paratyphosus* A were absorbed by an emulsion of the latter, whereas an emulsion of typhoid bacilli only absorbed the homologous agglutinins. According to this observation, we are merely dealing with an example of group agglutination. Co-agglutinins were

[1] Harvey and Wood. Quoted by Firth, Journal of the Royal Army Medical Corps, xix, p. 163.

In the same report from which the above excerpt is taken it is also stated that "in the case of a man who has been inoculated against enteric and whose serum gave a positive reaction to the *B. typhosus*, absorption with *B. paratyphosus* A will only reduce the agglutinin titre as it cannot remove the agglutinins due to inoculation which are specific for the *B. typhosus*." See Firth, Journal of the Royal Army Medical Corps, 1911, vol. xvii, p. 136.

certainly produced in some of our patients, but we doubt whether this is the whole explanation, as it did not occur when individuals not inoculated against typhoid were injected with a vaccine containing only *B. paratyphosus* A and *B. paratyphosus* B. We also tried to absorb the agglutinins for typhoid bacilli in two instances, where they were well developed, by shaking out with a strong mixed emulsion of paratyphoid A and B bacilli, but only succeeded in reducing them. The development of well-marked agglutination to typhoid bacilli weeks before the specific agglutinins arrived, suggest another interpretation, namely, that in an inoculated person, the mechanism for the manufacture of agglutinins being already laid down, the introduction of paratyphoid organisms stimulates this mechanism to further activity.

(2) *Agglutination of B. paratyphosus A or B. paratyphosus B or both of these Organisms.*—The serum of 326 cases agglutinated *B. paratyphosus* A or B in dilutions of 1 in 100 and upwards. In 238 of these, more or less agglutination of *B. typhosus* was exhibited also. Nevertheless, for reasons entered into above, in individuals inoculated against typhoid, these were returned as paratyphoid A or B fevers respectively and, whenever opportunity offered of confirming this by isolation of the infecting organism, the conclusion was found to be justified. With the dilutions we employed, in ninety-five per cent of the cases the results were unequivocal, but in 17 out of a total of 326 the serum agglutinated both *B. paratyphosus* A and *B. paratyphosus* B. The agglutination generally occurred in considerably higher dilution with one than with the other, so as to leave little doubt as to the diagnosis. In a few cases this was not so, and it was impossible to say from one examination which was the infecting organism, and later observations at intervals of about a week were made. At the same time efforts were made to recover the organism responsible for infection.

The following are examples illustrating how the diagnosis was cleared up by a second examination of the blood:—

			1 in 100	1 in 200	1 in 400	1 in 800
No. 538	6.11.15	Ty	+++	+++	+++	+++
		A	+++	++	–	–
		B	+++	+++	+++	+++
	18.11.15	Ty	+++	++	–	–
		A	–	–	–	–
		B	+++	+++	+++	+++

B. paratyphosus B was recovered from the fæces.

				1 in 100	1 in 200	1 in 400	1 in 800
No. 449	23.10.15	Ty	..	+ ..	− ..	− ..	−
		A	..	+++ ..	+++ ..	+++ ..	+++
		B	..	++ ..	++ ..	+ ..	−
	1.11.15	Ty	..	+ ..	− ..	− ..	−
		A	..	+++ ..	+++ ..	+++ ..	+++
		B	..	− ..	− ..	− ..	−

B. paratyphosus A was recovered post mortem.

				1 in 100	1 in 200	1 in 400	1 in 800
No. 548	7.11.15	Ty	..	++ ..	+ ..	− ..	−
		A	..	+++ ..	+++ ..	+++ ..	+++
		B	..	+++ ..	+++ ..	++ ..	+
	16.11.15	Ty	..	+ ..	− ..	− ..	−
		A	..	+++ ..	+++ ..	+++ ..	+++
		B	..	+ ..	+ ..	− ..	−
No. 379	16.10.15	Ty	..	+ ..	− ..	− ..	−
		A	..	++ ..	+ ..	+ ..	+
		B	..	+ ..	+ ..	+ ..	+
	15.11.15	Ty	..	− ..	− ..	− ..	−
		A	..	+++ ..	+++ ..	+++ ..	+++
		B	..	++ ..	+ ..	− ..	−

In making a diagnosis we have regarded the organism for which agglutinins persisted, as responsible for the infection. In those cases in which we succeeded in isolating the causal organism this view was justified.

The amount of co-agglutinins present at an early stage of the illness in five per cent of patients with paratyphoid fevers is noteworthy. Compared with our standard sera, made by injecting rabbits with a laboratory strain of paratyphoid A or B bacilli, it is considerable. It must be remembered, however, that the standard sera were made from strains selected on account of their specificity, whereas the "wild" strains occurring in nature are not always so specific. Further, it is probable that man is not as good an animal to use for the manufacture of highly specific sera for this group of organisms, resembling the horse in this respect rather than the rabbit.

Analysis of Observations.

We are now in a position to proceed to the analysis of our observations and see what indications they afford as to the distribution of different enteric fevers at Gallipoli. The 163 instances in which the serum gave no agglutination in the minimum dilution used, 1 in 100, may be summarily dismissed as they furnish no information. They comprise cases in which the serum was sent for examination too early in the disease and others in which the

subsequent clinical history indicated that the patient was suffering from some disease other than one of the enteric fevers. The total number of cases in which agglutination with one or more of the bacilli of the enteric group was observed was 464. Of these, 213 sera agglutinated *B. paratyphosus* A and are, for reasons given above, regarded as significant of paratyphoid A infection. For parallel reasons, we regard 113 as infections by paratyphoid B.

The determination of the number of typhoid infections is not so simple.

The 138 cases in whose sera only typhoid agglutinins were discovered were not necessarily typhoid fevers, for all but five of the patients had been inoculated. These five exceptions we place to the credit of typhoid infections on the agglutination findings. In seven other cases we succeeded in isolating *B. typhosus* from the blood or excreta either during life or after death, leaving 126 cases in which serological observations might be interpreted either by previous inoculation or by recent infection.

Medical officers were in the habit of sending blood to the laboratory for serological examination whenever they suspected that they might be dealing with a case of one of the enteric fevers and sometimes irrespective of the time the patient had been ill. Consequently, there are in this group a number of cases which subsequently proved to be dysentery, pneumonia, malaria, influenza, or relapsing fever. It also includes thirty-five cases of epidemic jaundice in which serological observations were deliberately made, as there was a widespread impression at first that the disease was associated with infection by a paratyphoid organism. We may eliminate these thirty-five cases of jaundice from further consideration, as, whatever the infective agent may have been, there is no evidence that it was due to a paratyphoid bacillus.

The remaining ninety-one cases were either investigated at the time, or their records carefully scrutinized for us by Lieutenant-Colonel Stawell, Consulting Physician to our Unit, and we take this opportunity of expressing to him our exceeding gratitude. Without his assistance in this matter it would not have been possible to draw what is, perhaps, the most important conclusion from our observations, namely, the relative prevalence of true typhoid fever at Gallipoli. After submission to his scrutiny, these ninety-one cases which might possibly have been typhoid infections were reduced to thirteen. This number includes all those which, on clinical grounds, might have been cases of one or other of the enteric fevers. It is certainly a maximal estimate for, as

mentioned above, we have reason to believe that some cases of paratyphoid A fever, which the method we employed failed to discover, are included in it.

The results of the analysis of our observations, after this eliminative procedure has been applied to the cases whose sera agglutinated only *B. typhosus*, are as follows:—

Cases of typhoid fever	25 ..	7 per cent
,, ,, paratyphoid A fever ..	213 ..	61 ,,
,, ,, paratyphoid B fever ..	112 ..	32 ,,
Total of enteric fevers ..	350	

The patients at No. 3 General Hospital, A.I.F., were derived from Gallipoli and the lines of communication. Imperial troops and Australians were indiscriminately admitted. As the sample covered by our observations was of fair size, we shall not commit a serious error if we apply our conclusions to the distribution of enteric fevers at the Dardanelles.

From information kindly furnished us by Lieut.-Colonel Aldridge, R.A.M.C., there were 5,700 cases returned as enteric fevers from this area from the commencement of the campaign until the middle of December, 1915. According to a statement made by the Under Secretary for War in the House of Commons on December 23, the total medical casualties during the same period were 96,683.

If we further assume that the distribution we have arrived at is applicable to the whole of this period, the invaliding rate from typhoid fever represents less than half per cent of the total sickness during the period.

This highly satisfactory result must, presumably, be attributed to anti-typhoid inoculation, for the conditions were not unfavourable to the spread of enteric disease.

As soon as we became aware from our observations that the great proportion of the cases of enteric fevers amongst Australian troops was due to paratyphoid infections, we represented the facts to the Director of Medical Services of the Commonwealth Forces and advised that Australian troops should be at once inoculated with a vaccine containing paratyphoid and typhoid bacilli. This recommendation was approved by the Minister for Defence and early this year all Australian Units were so inoculated.

Henceforth, the interpretation of observations upon the agglutination of enteric organisms will, in the case of patients belonging to Australian units, be too difficult to possess any practical value and the isolation of the infecting organism must be resorted to for diagnosis.

SERUM DISEASE AND ANAPHYLAXIS.

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THE symptom-complex known as "serum disease" is undoubtedly due to the action of the horse serum as a whole, the presence or absence of antitoxin being almost, if not quite, immaterial.

Symptoms may occur after the introduction of any foreign serum into the human economy by a route other than that of the alimentary canal; in the case of horse serum, they usually develop from the fifth to the twelfth day after the injection.

After a minimal incubation period of ten days, a second injection is very occasionally followed by sudden acute symptoms—anaphylaxis; the first injection has made the recipient more sensitive to the action of the second. The local reaction which occurs in a tuberculous subject after the injection of tuberculin, and the grave symptoms which sometimes result from the rupture or puncture of a hydatid cyst, are also regarded as the results of specific sensitization to a foreign protein.

Sudden acute symptoms also occur—though with extreme rarity—after a single injection of serum, so that no hard and fast line can be drawn between serum disease and anaphylaxis at the present time. Some of the principal points in connexion with this latter subject will therefore be dealt with first, the clinical and theoretical aspects of serum disease being discussed in Part II of this paper.

PART I.

ANAPHYLAXIS.

The symptoms vary considerably in different animals; rats seem to be relatively [15] and white mice absolutely immune. The following experiments illustrate the chief phenomena as they occur in the guinea-pig:—

A series of these animals receives 0·2 cubic centimetre of horse serum subcutaneously.

Of these, No. 1 may be given two cubic centimetres of horse serum intravenously at any time during the first five days without symptoms resulting. No. 2 receives an intravenous injection of

0·5 cubic centimetre on the fourteenth day; death occurs two minutes later (phenomenon of Theobald Smith). We explain these results by saying that after the fifth day the sensitiveness of the animal to a second injection of horse serum gradually increases. It has been found by experiment that the maximum degree of sensibility is reached after about a fortnight.

No. 3 receives an intraperitoneal injection of 0·2 cubic centimetre on the fourteenth day. Slight febrile symptoms follow, but recovery takes place within twenty-four hours, when a further injection of 0·5 cubic centimetre, given intravenously as in No. 1, does not give rise to symptoms. This experiment illustrates the fact that a sublethal dose given at the end of the incubation period causes desensitization, the guinea-pig apparently returning to its normal condition.

A second dose given *within* the incubation period also has a protective effect.

The term "anti-anaphylaxis" is often used in connexion with these phenomena.

No. 4 is bled to death fourteen days after the sensitizing injection. If two-thirds or more of the serum recovered from such an animal be injected into a normal guinea-pig, it becomes hypersensitive after a minimal latent period of four hours. Presumably the tissues are becoming passively sensitized during this interval; the condition is therefore known as "passive anaphylaxis."

Local Anaphylaxis.—Local œdema and finally gangrene occur after the repeated injections of horse serum into rabbits (phenomenon of Arthus) [2]. That this is also a phenomenon of sensitization is shown by the fact that gangrene only occurs in the neighbourhood of the last injection, wherever that may happen to be; the initial injections may even be intraperitoneal.

Although local anaphylaxis is particularly prominent in rabbits, similar accidents have been noticed in man and in other animals, although actual gangrene seldom results.

The Tissues affected by Sensitization and Intoxication.

That the primary change occurs in the blood is shown by the work of Otto [27], who found that guinea-pigs' serum transmitted passive anaphylaxis before sensitization could be demonstrated.

However, many facts indicate that in susceptible animals all the tissues are sensitized more or less. Local anaphylaxis in rabbits (phenomenon of Arthus) is a good illustration of widespread sensitization. Demel [13] has succeeded in sensitizing the hearts of

these animals to white of egg. Dale [12] has shown that the uterus of a sensitized guinea-pig, excised after a long perfusion with saline to wash out all the blood, gives an immediate and vigorous contraction on bathing it in a solution of the original antigen, etc.

Many of the symptoms of anaphylaxis are apparently due to the implication of the nervous system, but whether the poison acts centrally or peripherally has been much disputed; the available evidence points to its acting in both ways. Auer and Lewis [3], also Biedl and Kraus [9], have succeeded in preventing the dyspnœa which is such a marked feature of anaphylaxis in the guinea-pig by the preliminary injection of atropine. According to these authors, the dyspnœa is due to the mechanical obstruction produced by the spasm of the bronchial musculature, and they attribute the causation of this spasm to the action of the anaphylactic poison on the nerve endings in the muscle. Biedl and Kraus have further shown that the fall of blood-pressure, which is such an invariable feature in all severe cases of anaphylaxis, is not influenced —in dogs—by a subsequent injection of adrenalin, but that barium chloride, which has a direct action on plain muscle, stops it to a large extent. They therefore regard the action as being a peripheral one. Richet and Besredka are firmly convinced that the central nervous system is chiefly affected, at any rate in severe cases. Richet, in addition to criticizing the previous experiments, points out that irritative and paralytic phenomena occur which cannot be explained in any other way. So far as experimental work is concerned, an ingenious experiment devised by Belin [6] may be cited in support of this view. Taking advantage of the fact that the young of a guinea-pig can be sensitized *in utero*, he injected $\frac{1}{100}$ cubic centimetre of ox serum into a pregnant animal, three weeks before delivery. One of the young ones was killed by bleeding on the third day after birth, the rest of the blood being got rid of by repeated perfusion with normal saline. The brain, liver, thyroid and suprarenals were then removed. It was found that a mixture of brain emulsion and ox serum produced immediate symptoms of anaphylaxis in a normal guinea-pig, while the injection of similar quantities of serum emulsified with portions of the other organs removed at the autopsy or with normal brain substance had no effect.

Besredka claims that anæsthetics, such as alcohol and ether, suppress all symptoms of anaphylaxis in guinea-pigs, and that the animal awakes vaccinated after the injection of what would

otherwise have been a fatal dose. Banghof [4] obtained similar results with chloral hydrate. These experiments are not altogether confirmed by Rosenau and Anderson [29], the majority of whose animals died; however, these authors admit that anæsthetics mask the symptoms.

The Theory of Anaphylaxis.

Notwithstanding the large amount of work done on this subject in recent years, little real progress has been made, and we have no exact knowledge of the mechanisms by means of which sensitization, desensitization and intoxication are produced. No doubt this is chiefly due to the complexity of the subject, but at the same time it seems unfortunate that so many investigators have persuaded themselves that anaphylaxis can be explained on purely chemical lines. The existing theories as to the way in which the actual symptoms of intoxication are brought about are nearly all chemical, the conception of specific antibody formation being basic and fundamental. Yet there is much evidence in favour of the view that these phenomena are of a physical rather than of a chemical nature.

Consideration of the More Important Chemical Theories.

(1) Richet [28] demonstrated that the serum of a sensitized animal, when mixed with the original antigen, often produced symptoms of anaphylaxis when injected into a normal animal (anaphylaxis *in vitro*). He accordingly regards the first or sensitizing injection as leading to the formation of a substance—*toxogenin*—in itself non-toxic, but capable of combining with the antigen introduced at the second injection to form the true toxin.

(2) Besredka [8] only differs from Richet in committing himself to the view that cellular sensitization by the circulating antibody is an essential preliminary. Like Richet, he makes no attempt to explain the underlying mechanisms.

(3) The theory of parenteral digestion. In 1910, Hartoch and Ssirensky [22] found that horse serum, after digestion with trypsin, produces symptoms which are indistinguishable from those of anaphylaxis; 0·2 cubic centimetre of horse serum + two cubic centimetres of trypsin mixture was devoid of toxicity if injected intravenously into guinea-pigs immediately after mixing. However, after three hours' digestion the same dose produced slight symptoms, while after six days death occurred with regularity. On the strength of this experiment, authors are not wanting who suggest that the injection of foreign proteins is

followed by the production of specific antibodies (ferments), which digest them with the production of toxic substances; the second injection of antigen is supposed to give rise to symptoms by accelerating the rate of their production. When, however, we remember that anaphylaxis may occur during the progress of an intravenous injection, the improbability of increased ferment production and proteolytic digestion taking place with sufficient speed to cause the symptoms is evident.

Still, in spite of such drawbacks, the theory of parenteral digestion is of the greatest interest as being the first to give any concrete explanation of the phenomenon of sensitization, while the fascination of the whole subject has been greatly increased by the work of Jobling and Petersen [23].

Starting from the fact that proteolytic ferments can be demonstrated in the majority of sera, these workers showed that their action is normally inhibited by the presence of lipoids (unsaturated fatty acids); that if these substances be extracted from the serum by means of alcohol and ether, the serum becomes highly toxic—even for its own species—but that this toxicity disappears on returning the extracted lipoid; that toxicity in the absence of lipoids is due to exposure of the serum proteins to the action of the trypsin, with the resulting formation of toxic, split products.

They also found that iodine, potassium iodide and hydrogen peroxide could remove the antitryptic property of the serum by saturation or oxidation of the unsaturated carbon bonds upon which the antitryptic property of the fatty acids apparently depends.

Taking advantage of these facts they showed that the reduction of antitrypsin obtained in a guinea-pig by painting its shaved skin with tincture of iodine was sufficient to make it susceptible to what would otherwise have been a sub-lethal dose of serum. This remarkable experiment would seem to indicate that symptoms may result from exposed protein in the animal injected, as well as in the antigen.

Objections to Chemical Theories in General.

Suggestive and interesting though such experiments may be, insuperable objections to all chemical theories nevertheless exist; some of these may be considered under the following headings:—

(1) Evidence as to the formation of antibody.

(2) Clinical evidence.

(3) The neglect of certain experimental facts.

Evidence as to the Formation of Antibody.—There is no proof

that antibody formation really occurs. Although the phenomena of passive anaphylaxis show that the serum of the animal injected has acquired new properties, this cannot be interpreted as proving the reality of antibody formation. No one has ever succeeded in neutralizing the toxic properties of a foreign serum by mixing it with the serum or other tissue of a protected animal. Again, we have just seen that the mere painting of the skin of a guinea-pig with tincture of iodine is sufficient to sensitize the animal to an injection of horse serum! The increasing prevalence in the use of such terms as "immune body" and "antibody" in connexion with anaphylactic phenomena must therefore be strongly deprecated; the conception of an organism elaborating immune body for its own destruction is not a happy one, and invites confusion of thought.

Clinical Evidence.—It has long been known that serious and even fatal symptoms may occur in man immediately after a single injection of serum. The usual explanation given is that such an individual had become sensitized to horse serum owing to the previous ingestion of horse meat in the form of sausages, etc. However, the fanciful nature of this supposition is shown by the fact that herbivorous animals may also develop immediate symptoms after a single injection. Sobernheim [30] reports that a few out of the thousands of cattle treated with anti-anthrax serum were extremely ill immediately afterwards, although they had received no previous injection of any sort. In addition to the general disturbance, there was œdema of the muzzle and eyelids, together with an abundant nasal discharge.[1]

Experimental Evidence.—The following experimental work has not yet received the attention its importance deserves:—

(*a*) Wells [37], working with a pure egg albumen, obtained by repeated recrystallization, showed that sensitization and intoxication could be effected by the same chemical substance. On subjecting this albumen to tryptic digestion, he found that both principles were attacked and slowly diminished in strength as the coagulability disappeared. Wells also claimed that one-twentieth of a millionth part of a gramme sensitized sufficiently for a second injection to produce symptoms, while one-millionth of a gramme sensitized fatally. These facts, taken in conjunction with the evidence showing that a single injection of foreign protein affects all the tissues of

[1] Similar symptoms occur after the second injection in a larger proportion of animals (ten per cent).

an animal more or less, makes it difficult to accept the view that the action is a purely chemical one.

(*b*) Wassermann and Keysser [35] found that if normal serum be mixed with kaolin—a chemically inert substance—and centrifuged, the supernatant fluid is very toxic and kills a healthy guinea-pig in a few minutes with symptoms indistinguishable from those of anaphylaxis. Struck by this experiment, Bordet [10] has suggested that the antigen-antibody complex adsorbs certain principles from the blood plasma, which then becomes toxic. This is a step in the right direction, but, as we have already seen, there is no proof that antibody formation occurs.

(*c*) Doerr and Moldovan [14] have discovered that the intravenous injection of inorganic colloids may cause immediate anaphylaxis. For example, the intravenous injection into a guinea-pig of one centimetre of a 0·7 per cent solution of colloidal silica gives rise to immediate symptoms, followed by death in a few minutes. That the mechanisms underlying these symptoms have much in common with the mechanisms which give rise to anaphylaxis of the classical type is shown by the fact that certain well-known differences in the manner in which dogs and guinea-pigs react to the anaphylactic poison are faithfully reproduced.

The only reasonable explanation of these experiments is that colloidal silica exerts some toxic physical action on the tissues of the animal injected. Now the action of inorganic colloids is usually to give rise to mutual precipitation when mixed with protein solutions, and from the work of Lillie [24] and Dale [12] it seems probable that the immediate contraction which results on placing a piece of sensitized muscle in a solution of the original antigen is due to the colloidal interaction which takes place on the surface of the muscle, increasing the permeability of the cell membrane. The importance of this latter factor is emphasized by the work of Lillie, who experimented with the larva of a marine annelid, *Arenicola cristata*. This little animal has a well-developed musculature, while its cells contain a yellow, water-soluble pigment ; at death or under the action of any cytolytic substance, this pigment diffuses into the surrounding water, so that its exit may be taken as evidence of an increased permeability of the cell membrane. On removing the larva from sea-water to a solution of pure isotonic sodium chloride, a strong and persistent muscular contraction immediately followed, while the intracellular pigment diffused into the surrounding solution ; if the stimulating action was checked by the addition of a

little calcium or magnesium chloride, the loss of pigment was also checked to a proportionate degree.[1]

These characteristic effects were produced by all the strongly stimulating solutions tested. The powerfully stimulating effect produced by concentrated solutions of anæsthetics, such as chloroform and ether, were also associated with rapid loss of pigment, but weaker solutions of these substances merely produced anæsthesia without loss of pigment. Such weak solutions were found to protect the larvæ against the action of pure isotonic sodium chloride, chloroform having decidedly greater protective action than ether.

(*d*) Subcutaneous injections of inorganic colloids are innocuous apart from the occasional occurrence of local inflammation and gangrene. Local anaphylaxis is brought into line with these observations by the work of Uhlenhuth [31], who long ago came to the conclusion that the serum of one animal is, in general, toxic when injected into an animal of another species. He showed—and his work has been confirmed—that the subcutaneous injection into guinea-pigs of 0·5 cubic centimetre of human, rabbit, pig or sheep serum leads to local infiltration, while the injection of fifteen to twenty cubic centimetres leads to necrosis. He also showed that horse serum is considerably less toxic than most other sera.

Conclusions.

In the first place it is evident that the term "anaphylaxis" cannot be restricted to the phenomena which occur after the second injection of a foreign protein, and that no theory can be accepted which does not explain "immediate anaphylaxis" as well as the classical phenomena which occur after preliminary sensitization.

It is difficult to resist the conclusion that sensitization and intoxication are brought about by physical rather than by chemical means. In both cases a physical alteration of the plasma, whereby it becomes toxic, seems to be an essential preliminary. The severity of the symptoms probably depends on the liability of certain groups of cells—perhaps situated for the most part in the nervous system—to be affected by slight changes in the permeability of their cell membranes. If a quantity of toxin,

[1] In this connexion it is interesting to note that many clinicians have obtained good results in serum sickness by administeriug calcium chloride for several days before the injection of serum.

insufficient to produce symptoms, is liberated, the animal becomes sensitized to a variable extent. Probably physical theories will soon be evolved to explain these and other anaphylactic phenomena. If physical chemistry could only give us an explanation of the specificity which is so marked a feature in immunity and anaphylaxis, great strides in these subjects would in all probability be quickly made.

PART II.

Some of the Clinical Aspects of Serum Disease.

I.—*Symptomatology.*

The more common manifestations of serum disease are pyrexia, pruritus, skin eruptions, œdema, adenitis, and pains in the joints. Occasionally the mucous membranes are affected. More rarely still there is a variable amount of collapse, with or without involvement of the respiratory apparatus. The accompanying table gives a summary of the symptoms in 250 consecutive cases:—

TABLE I.—Summary of Symptoms in 250 Cases of Serum Disease.

Symptoms	Percentages	
Local itching only	4·4	4·4
,, erythema without irritation	0·8	
,, ,, + itching	6·4	
,, ,, ,, + adenitis	2·4	
,, exanthem other than simple erythema + itching	47·6	69·2
,, ,, ,, ,, ,, ,, ,, + œdema	2·0	
,, ,, ,, ,, ,, ,, ,, + adenitis	8·0	
,, ,, ,, ,, ,, ,, ,, ,, + œdema	0·4	
,, ,, ,, ,, ,, ,, ,, + joint pains	1·6	
,, and general exanthem + itching	16·4	
,, ,, ,, ,, + local œdema	2·0	
General exanthem, but no local + itching	0·8	
Local and general exanthem + itching + œdema other than local	0·8	
,, ,, ,, ,, + adenitis	3·2	
,, ,, ,, ,, ,, + local œdema	0·4	
,, ,, ,, ,, ,, + œdema other than local	0·8	26·4
,, ,, ,, ,, ,, + œdema other than local + joint pains	1·2	
,, ,, ,, ,, ,, + œdema other than local + joint pains + considerable pyrexia and rapid feeble pulse	0·4	
Local and general exanthem + itching + adenitis + œdema other than local + joint pains + considerable pyrexia and rapid feeble pulse + oral urticaria and œdema of larynx	0·4	
		100

These will now be considered in greater detail.

Pyrexia.—According to von Pirquet and Schick [34], fever is the commonest symptom. However, Weaver [36] says it is

inconstant and that cases of severe urticaria may run an afebrile course. I entirely agree with him.

Local Irritation.—In eleven cases (4·4 per cent) local itching was the only thing complained of. In the majority of these it was noticed for a few hours only, but in one case the irritation recurred at the same time each day for seven days, lasting for about an hour on each occasion. Although not specially mentioned by other observers, there would seem to be doubt that such cutaneous hyperæsthesia represents the mildest form of the disease.

TABLE II.—Cases in which Local Itching was the only Symptom.

Number of case	Date of appearance	Duration
1	Third day	One day.
2	Third day	One day.
3	Third day	Two days.
4	Third day	Three days.
5	Fourth day	One day.
6	Fifth day	One day.
7	Sixth day	Two days.
8	Sixth day	Seven days.
9	Eighth day	One day.
10	Tenth day	One day.
11	Eleventh day	One day.

Exanthem.—In two cases (0·8 per cent) a local transient erythema, unaccompanied by any itching, was noticed. Probably such cases should be excluded; a similar phenomenon sometimes occurs after the injection of normal saline. A local exanthem accompanied by a certain amount of itching was noticed in 171 cases (68·4 per cent). In the remaining 66 (26·4 per cent) the rash was found in other situations, usually extending all over the body. In 60 out of 66 it was local to start with. In 2 of the remaining 6 it was both local and general when first noticed; in 2 more it was general first and local later, while in the remaining 2 the local exanthem was absent. In 156 out of 239 the rash was entirely urticarial; in the remaining 83 it was erythematous, morbilliform or mixed. The itching is supposed to be more marked at night; in the majority this was so, but the converse held in a fair proportion.

Œdema.—Œdema was observed in twenty-one cases (8·4 per cent); in the majority it was a purely local phenomenon.

Lymphatic Glands.—In 43 cases (17·2 per cent) one or more enlarged and painful glands was found. In 40 out of the 43, the group of superficial glands nearest the site of inoculation was alone involved.

In one of the remainder, the superficial glands were enlarged and painful all over the body. The second patient had been injected in the left lower abdomen. On the eighth day a local rash was noticed, together with enlarged and painful left inguinal and left axillary glands. According to von Pirquet and Schick this happens sometimes; it is presumably due to an anastomosis between the smaller lymphatic vessels in the intermediate area.

In the third, the serum had been injected on the right side of the thorax. A painful and enlarged gland was noticed in the *left axilla* on the following day, but at the end of twenty-four hours it was practically normal again; nothing was found to explain its presence apart from the injection of serum. A local rash made its appearance on the third day. Possibly the gland in question had been previously damaged and was therefore more susceptible.

Involvement of Joints.—Joint pains were complained of in nine cases (3·6 per cent). Their incidence would seem to vary with different conditions. Thus, according to Hartung (Germany), the average is just under one per cent, while joint pains were complained of in twenty per cent of Weaver's cases (America).

Albuminuria.—The presence or absence of albumin was not investigated sufficiently thoroughly to make the results worth recording. According to von Pirquet and Schick it is transient and occurs but rarely.

Mucous Membranes.—In one case there was œdema of the larynx, together with urticarial spots on the oral mucosa and vomiting. Bloody diarrhœa has been reported by Hartung, but is excessively rare.

Collapse.—The circulatory system was affected in two cases. No organic or functional disease of the heart was discovered, and the previous injection of serum was denied in both. A short description is appended:—

Case 1. — Pte. P., admitted suffering from slight shrapnel wound of shoulder; this had practically healed on admission, and there was no pyrexia. Symptoms started on the sixth day after the injection of ten cubic centimetres into the left upper arm. These consisted of a local urticarial rash, which was accompanied by pains in both knees; faintness and giddiness were complained of on getting out of bed, while the temperature rose to 100° F. On the seventh day the glands in the left axilla were swollen and painful; towards evening the patient vomited twice; other symptoms as before. On the morning of the eighth day local

œdema was marked, while the rash had become generalized; there was giant urticaria all over the body, and the itching was intense. Pain was complained of in nearly all the joints, while most of the superficial lymphatic glands were painful and enlarged. At night the temperature rose to 103·4° F. On the morning of the ninth day the temperature had fallen to 99° F., but the pulse was so feeble and rapid as to be uncountable. There were urticarial spots on the oral mucosa, and the patient was so hoarse that he could hardly speak. Towards evening the pulse fell to ninety per minute and was stronger. On the tenth day the hoarseness had gone, the temperature was normal and the pulse much improved, while the rash had practically disappeared. In all the rash lasted five days, the joint pains six days, and the adenitis seven days.

Case 2.—Pte. S. This patient was also suffering from a slight shrapnel wound which had practically healed on admission; there was no pyrexia. Local œdema and urticaria developed on the eighth day after the introduction of ten cubic centimetres of serum into the left arm. A few hours later the rash became generalized and was accompanied by intense itching; there was also pain in the left elbow-joint. On the ninth day pains were complained of in practically all the joints, including the fingers and toes; there was also pain in both loins, while the urine contained a trace of albumin for the next three days. From the eleventh to the fifteenth day the temperature varied between 100° F. and 102° F. During the same period the pulse varied between 100 and 112 per minute; on the twelfth day it was particularly feeble, while the patient complained of much pain and seemed collapsed. On the thirteenth day he was considerably better, and by the sixteenth day all symptoms had disappeared.

Dyspnœa.—In no case out of the 250 was any involvement of the respiratory apparatus detected.

II.—*Diagnosis.*

The presence of a local exanthem, or of itching, would seem to be the earliest and most reliable sign. Either the one or the other was the first thing noticed in 96·4 per cent of cases. In 1·6 per cent the general exanthem was observed either first or at the same time as the local. In the remaining two per cent an enlarged and painful gland was the first sign. Joint pains never seemed to occur first in point of time, although occasionally noticed within a few hours of the exanthem.

III.—*Differential Diagnosis.*

Rashes due to enemata, drugs and articles of diet, seldom give rise to any difficulty in practice.

IV.—*Treatment.*

I have little to say about the treatment, which is purely symptomatic. Calcium chloride and calcium lactate were not found to be of much value in relieving the pruritus, but as they were not given before symptoms developed, much benefit could hardly have been expected; the originators of this treatment only claimed to get good results when these drugs were given for several days previous to the injection of the serum.

V.—*Prophylaxis.*

Weaver makes the following recommendations:—

(*a*) If more than ten days have elapsed since a previous injection, a small initial dose should be given. A full dose—subcutaneous, intravenous or subdural—may be given on the following day or, if absolutely necessary, within a few hours.

(*b*) The same precautions to be taken before the first injection in asthmatics and in people subject to urticaria.

(*c*) Care to be taken in avoiding the puncture of a vein when making the injection.

The Effects of a Second Injection of Serum.

(1) *When the Second Injection is given Shortly after the First.*— In thirty-eight cases a second injection was given shortly after the first, in no case later than the sixth day. Twenty-three of them were under observation for at least a fortnight, and of these twenty developed symptoms. The rash usually appeared first at the original site of injection, occasionally at the secondary site, sometimes in both places simultaneously; its duration and severity were sometimes more marked in one situation, sometimes in the other. Whether the second injection was given immediately after the first, or whether several days elapsed between the two, seemed to make little difference; moreover, the second injection did not appear to retard or accelerate the appearance of symptoms in any constant manner, or to affect their severity when present. The following case (Pte. W.) is typical, apart from the curious regularity of the time relations:—

First injection given in right arm July 31, 1915, at 12 midnight.

Local itching and urticaria started August 7, 1915, at 2 a.m. Second injection into left side of chest August 1, 1915, at 12 o'clock in the morning. Local itching and urticaria started August 7, 1915, at 2 p.m.

The arm alternated with the chest for twelve days, but the two arms were seldom affected at the same time. The intensity of the irritation varied considerably, but was not more marked at night. These conclusions are in harmony with those of Currie [11] and Goodall [19]; other observers do not seem to have paid much attention to the matter.

(2) *When the two Injections are Separated by an Interval of at least Ten Days.*—This question was first investigated by von Pirquet and Schick in 1905. They give the following figures (Table III), and point out that the reaction may be "immediate" or "accelerated,"[1] that during the first month the immediate reaction is invariable, but that both occur up to six months, after which the accelerated reaction predominates.

TABLE III (von Pirquet and Schick).

Interval between first and second injections	Total number of cases	Immediate reaction	Accelerated reaction	Immediate + accelerated
Ten days to one month	24	21	—	3
One to six months	33	21	5	7
More than six months	34	2	30	2

Curiously enough no other authors lay any great emphasis on these reactions. Goodall, in a series of ninety cases, found that immediate reactions developed in 18·8 per cent, accelerated reactions in thirty-three per cent.

Personal Observations.—Notes were made of fourteen cases in which the interval varied between six weeks and ten months. No case of immediate reaction was noticed, although a six months' interval was only exceeded three times. In eight cases the reaction was accelerated. In four cases the symptoms appeared on the same day after both injections. In one case there was no reaction on either occasion. In one case a local followed by a general reaction occurred about a week after the first injection, while nothing happened after the second one, two months later.

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[1] If the incubation period is somewhat shorter after the second injection than after the first, the reaction is said to be "accelerated." If it is so much reduced that symptoms occur within twenty-four hours, the reaction is said to be "immediate." The *immediate reaction* is usually confined to the infiltration and œdema in the neighbourhood of the injection, although severe general symptoms may occur.

These cases confirm the view that immediate and accelerated reactions are comparatively rare. Why von Pirquet and Schick met with such a high proportion is uncertain; possibly an exaggerated sensitization of the skin took place owing to the fact that many of their cases received very large doses (100 cubic centimetres to 200 cubic centimetres) on the first occasion. The skin apart, sensitization in man is extremely rare. It has even been stated that fatal accidents happen just as frequently after a single injection of serum [18]; in reality the available statistics are insufficient to settle the question. Although thousands of people receive a second injection every year, grave symptoms rarely develop.[1] Martin [25] says that in 5,000 cases he has never seen a true case of anaphylaxis, and this is by no means a unique experience. Man reacts to such injections in quite a different way to the guinea-pig. Obvious sensitization after the initial dose of serum is invariable in this animal, but uncommon in man; *per contra*, a single subcutaneous injection of horse serum hardly ever gives rise to symptoms in the guinea-pig.

That symptoms may develop in man from within a few minutes after the injection up to twenty-three days is another remarkable fact. All the antitoxin has reached the blood-stream within forty-eight hours, and it is hardly likely that the serum proteins remain unaltered for a much longer period; probably in the majority of cases their digestion commences soon after absorption from the subcutaneous tissues, the rate varying with the individual.[2] While the cases in which symptoms occur within a few minutes or hours of the injection are undoubtedly due to the chemically unaltered serum, those cases with a longer incubation period probably owe their existence to its split products. We have already seen that the intravenous injection of the products of the tryptic digestion of serum is capable of producing immediate symptoms of intoxication in guinea-pigs, although the injection of a corresponding quantity of undigested serum is without effect. This proves that the split products are very definitely toxic for this animal, although never present in sufficient quantity to produce symptoms after an injection of serum. Man, however, is far more sensitive to their action, as the various manifestations of serum disease show. The

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[1] Every year in Paris alone, about 1,000 children each receive two to four injections of serum [24].

[2] That the serum proteins are digested is shown by the fact that they are not excreted as such.

fact that the symptomatology is not markedly altered by variations in the length of the incubation period make it probable that they act in much the same way as the original serum protein.

The fact that symptoms do not occur for several days after the serum has been absorbed, taken in conjunction with the fact that they nearly always appear first around the site of injection, points to the existence of a sensitizing mechanism. In Part I attention was drawn to the fact that a sensitized guinea-pig may be immunized or killed according to the quantity of serum injected, Besredka's explanation being that a small dose desensitizes the animal, but not quickly enough to produce symptoms. May not serum disease also be the expression of a desensitizing mechanism? May not the fact that man is sensitized with such difficulty be due to the vast majority of susceptible people desensitizing themselves after each injection?

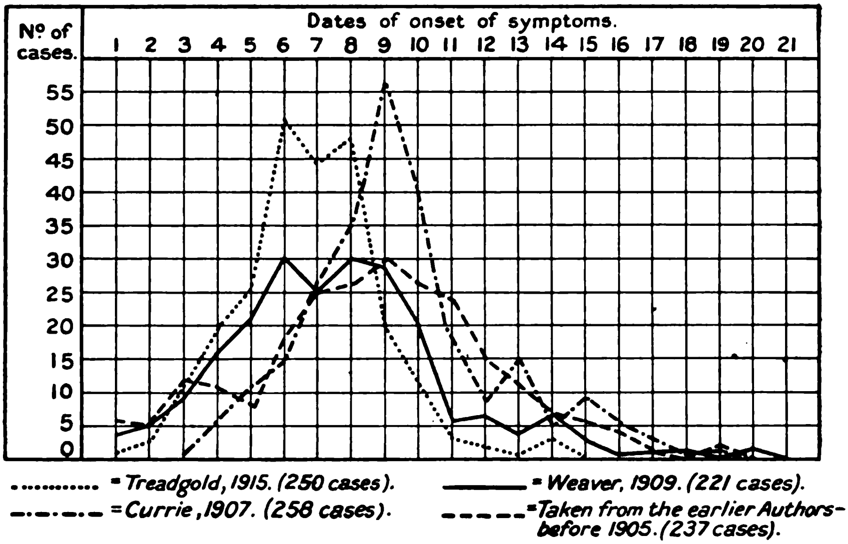


Chart 1.

Variations in the Length of the Incubation Period.

(1) *Sudden Onset.*—The incubation period may be very short; examples of this were given in Part I. In the present series, two cases out of 250 developed symptoms within two hours of the injection. These consisted of local and general urticaria accompanied by severe pruritus.

In No. I they lasted for two hours and then suddenly disappeared, the patient leaving hospital on the tenth day without anything else being noticed.

No. II was covered with giant urticaria for the great part of the five days he was in hospital, but developed no other lesions during this period. There was no history of urticaria or of the previous injection of serum in either case. No enemata had been given and the symptoms were unaccompanied by intestinal disturbance.

(2) *Late Onset.*—I have never seen a case start later than the fourteenth day. However, the statistics given by different authors show that a fortnight's incubation period is exceeded in about six per cent. Hartung mentions a case in which symptoms started on the twenty-third day.

(3) *Average Duration.*—Symptoms started on the sixth, seventh or eighth day in nearly sixty per cent of cases, about twenty per cent occurring on each day; no other day showed more than ten per cent. No series in the literature has such a short average incubation period (Chart 1).

TABLE IV.

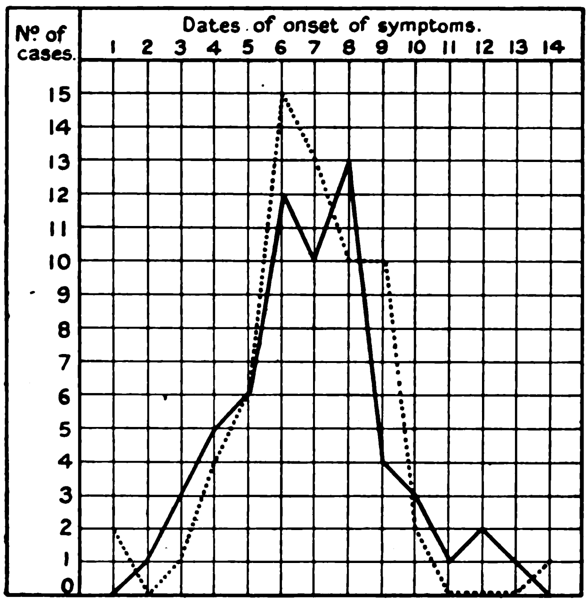
	Local exanthem	Local + general exanthem
1st day	0	2
2nd ,,	3	0
3rd ,,	10	1
4th ,,	16	4
5th ,,	19	6
6th ,,	36	15
7th ,,	30	13
8th ,,	38	10
9th ,,	10	10
10th ,,	10	2
11th ,,	3	0
12th ,,	7	0
13th ,,	1	0
14th ,,	1	1
	184	64

If the numbers in the first column be divided by three, these results may be represented graphically (*vide* Chart 2).

Relation between Length of Incubation Period and Severity of Symptoms.

Von Pirquet and Schick state that severe cases are usually associated with a short incubation period. If the symptoms are really severe, this statement is probably correct; for example, the two worst cases in the present series both started on the sixth day.

If either the circulatory or the respiratory systems be definitely affected, the case may be regarded as a severe one; no attention should be paid to the character of the exanthem, for the whole body is frequently covered with urticaria without any other special symptoms being present; moreover, the incubation period is not appreciably shorter in patients with a generalized eruption, as Table IV shows.



.... = *Cases with general exanthem. (64).*
——— = *Cases with local exanthem. (61).*

CHART 2.

FACTORS WHICH INFLUENCE THE DEVELOPMENT OF SERUM DISEASE.

In the present series, symptoms developed in 70·8 per cent.[1] Much lower figures were given by the earlier observers. Up to 1906 symptoms appear to have occurred in from ten to twenty per

[1] This figure was arrived at in the following way: Out of 562 surgical cases admitted to No. 24 General Hospital during the month of August, 1915, over one-third (202) were found to be suffering from disabilities such as hernia, varicose veins and sepsis, or from the result of accidents such as sprains and fractures. Of the remaining 360 who had been wounded, and had in consequence received a prophylactic injection of antitetanic serum, over one-half (199) were sent to

cent of cases only; since then, however, the figure has been distinctly higher (Table V).

TABLE V.

Number of cases		Average quantity of serum injected		Percentage affected		Author	Date		Country
474	..	About 43 cubic centimetres	..	54·6	..	Currie	1907	..	England.
692	..	,, 37 ,, ,,	..	31·1	..	Weaver	1909	..	America.
161	..	,, 15 ,, ,,	..	70·8	..	Treadgold	1915	..	British troops in France.

The reasons for these variations will be briefly considered under the following headings :—

(1) The quantity of serum injected.

(2) Possible variations in its toxicity.

(3) The personal equation.

The Quantity of Serum Injected.—This is not a feature of outstanding importance, although most authors agree that the percentage incidence rises in rough agreement with the increased dose. Be this as it may, Table V shows that the small doses of serum may be associated with a higher percentage of cases than large. This must be attributed either to differences in the toxicity of the serum or to differences in the sensitiveness of the individuals injected.

Variations in the Toxicity of Serum.—It is well known that some sera are more toxic than others, and that fresh serum is more toxic than old. Yet there should be little difference in the toxicity of the serum supplied by different laboratories for the following reasons :—

(*a*) The horses are always tested; for example, at the Pasteur Institute, if $\frac{1}{20}$ cubic centimetre serum produces grave symptoms when injected subdurally into a sensitized guinea-pig, that horse is rejected.

(*b*) The sera from different animals are almost invariably mixed before putting up for use.

England or to the convalescent camp within the fortnight. Of the 161 who stayed in hospital a fortnight or longer, 114, or 70·8 per cent, developed symptoms. The following facts show the improbability of this figure being an over-estimate: (1) According to von Pirquet and Schick, a rise of temperature may be the only indication of serum disease. However, I paid little attention to this symptom owing to the difficulty of distinguishing the serum pyrexia in any considerable proportion of cases from the fever associated with the usually septic wound. No case was included with this symptom alone. (2) On the average, symptoms commence after the fourteenth day in about six per cent. Personally, I have not seen a case start after the fortnight; however, few were under observation for a much longer period than this.

(*c*) Besredka states that the additional toxicity of fresh serum has disappeared by the end of two months.

(*d*) Besredka states that in experimental work on guinea-pigs, anaphylactic troubles are less noticeable at Paris than at Frankfort, and far less marked than at Washington. However, Rosenau and Anderson experimented with serum received from Besredka, and came to the conclusion that it was just as toxic as American serum, and that American guinea-pigs were probably more sensitive than French ones. Both in this country and in America sterilization of the serum is effected by filtration, and, according to Berg [7] and others, the number of cases of serum disease is considerably reduced in consequence. At the Pasteur Institute all sera are sterilized by heating for one hour at 56° C. on four successive days, and Besredka states that their toxicity is greatly diminished thereby. However, as previously noticed, Rosenau and Anderson could not detect any difference between French and American serum in this respect.

(3) *The Personal Equation.*—This would seem to be a factor of very great importance; it will be considered under the heads of experimental and clinical evidence.

Experimental Evidence.—We have previously seen that American guinea-pigs are probably more sensitive to the injection of serum than French ones. This is supported by the fact that French guinea-pigs are not at all susceptible to intraperitoneal injections, while in both America and in Russia these animals are very sensitive to the action of serum introduced by this route. Finally, Vasconcellos [32], working in Rio de Janeiro with Brazilian guinea-pigs, found some difficulty in producing anaphylactic symptoms, although fresh ones obtained from the Argentine were very sensitive.

Clinical Evidence.—(*a*) On looking at any single author's figures we find that the injection of large quantities of serum is usually associated with a higher case-incidence than the injection of small. Yet, if we compare different lists of statistics, as in Table V, we see that in one series a small dose may be associated with a much higher case-incidence than a large dose in another series. If there is no great difference in the toxicity of the sera manufactured in different countries, we must suppose that differences in racial and individual susceptibility exist as they do in the guinea-pig; possibly the sensitiveness of any given individual is subject to fairly wide fluctuations, being influenced by the various factors—both temporary and permanent—which contribute to the

formation of his individuality. Age alone does not seem to be a factor of any great importance.

(*b*) Any single list of cases shows great variations in the length of the incubation period (Chart 1). Von Pirquet and Schick regard these variations as due to individual pecularities, and this view is shared by all recent observers. Chart 1 also shows that the *average length* of the incubation period varies considerably in different lists.

The fact that in the present series a small dose was united with a short incubation period and a high case-incidence suggests either that the serum was unusually toxic or that the individuals injected were unusually sensitive; from the evidence available, this latter would seem to be by far the most important factor. If the serum was not more than usually toxic—and there is no reason for supposing it to have been—something must be at work which tends to increase the susceptibility of the troops as a whole. In addition to such factors as the change of life resulting from active service, it is possible that protective inoculations play a part in rendering the men more sensitive to the presence of a foreign serum. Gay and Southard [17], Dale and others have shown that the specificity of different antigens is by no means absolute, while Richet states categorically, "que les animaux sensibilisés par une substance anaphylactisante sont, dans une certaine mesure, sensibilisés pour tous les poisons, même cristalloïdes."

Conclusions.

The more important points may be summarized as follows:—

(1) "Accelerated reactions" are very far from being invariable, while "immediate reactions" are comparatively rare.

(2) Dangerous sensitization after the injection of *horse serum* is very seldom seen in the human subject.

(3) While in anaphylaxis, sensitization and intoxication are effected by the unaltered antigen, the symptoms of serum disease are mostly due to the toxic action of the split products.

(4) All these phenomena are due to a series of physical or physico-chemical changes, the nature of which is very imperfectly understood at the present time.

(5) The reasons for variation in the toxicity of horse serum, for the variable tolerance shown by different individuals and communities to its presence, etc., are problems of the greatest interest and importance from the point of view of the individual, from the

point of view of the race, and from the point of view of general biology; no opportunity of adding to our knowledge of these matters should be missed.

I have to thank the Divisional Surgeon at No. 24 General Hospital, Major Copeland, and also the other officers of the surgical division, for their great kindness in allowing me to examine their cases.

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ARRANGEMENTS FOR THE CARE OF CASES OF NERVOUS AND MENTAL SHOCK COMING FROM OVERSEAS.

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In view of the widespread interest taken in the soldiers sent home from the British armies overseas who are suffering from nervous shock, neurasthenia and mental breakdown, the Director-General has permitted me to contribute the following information upon the arrangements provided in this country for the care and treatment of these patients.

Cases of nervous and mental breakdown due to shock, fatigue, exposure and the other conditions incidental to a campaign began to arrive in England in September, 1914, shortly after the commencement of hostilities. The cases showed a varied symptomatology, but they could be classified into three main groups. One group was recognized whose symptoms were due to the bursting of high explosive shells in the immediate vicinity of the patient or to the secondary effects of the explosion, such as burial under earth and débris or the inhalation of noxious gases. The second group consisted of cases of a general neurasthenic character (using this term in its widest sense), attributable to exhaustion of the nervous system resulting from physical and nervous strain, sleeplessness, fear, anxiety, and harassing sights and experiences. The third group included cases of mental breakdown—the milder as well as the more severe psychoses, mental confusion, mania, melancholia, and delusional and hallucinatory psychoses.

At the commencement of the War, the cases of nervous shock and neurasthenia were transferred from overseas in company with medical and surgical cases, and were treated in the general wards of the hospitals at which they arrived, while the cases of mental disorder were transferred to D Block, Netley, the established institution for the treatment of mental patients in the service of the Army.

As cases of nervous breakdown of all kinds were coming over in considerable numbers in consequence of the severe fighting during

October and November, 1914, and as it was deemed desirable that special provision should be made for their treatment, Sir Alfred Keogh commissioned a special medical officer to proceed to France to report upon the cases, their nature and numbers, and the conditions under which their treatment should be carried out to the best advantage both during the preliminary stages in France and afterwards on their arrival in this country. The general purport of the report was to the effect that the cases of nervous shock and neurasthenia should be given treatment in hospitals for nervous diseases and in special institutions provided for the purpose, under the care of physicians with special neurological knowledge. In consequence, arrangements were made whereby cases of neurasthenia and nervous breakdown were labelled on their departure from the base hospitals by medical officers with special qualifications for this work and were transferred directly to the special hospitals and institutions provided for their treatment at home. By these means cases of functional paralysis, neurasthenia and the milder psychoses were separated as early as possible from cases of severe mental disorder.

The special institutions consisted of the hospitals for nervous diseases and the Red Cross Military Hospital, Maghull. This institution, which was built to meet the requirements of the Mental Deficiency Act, was handed over to the War Office in December, 1914, as it was necessary to have a hospital suitable for those "borderline" cases which required more special supervision than could be given in hospitals. It was desirable, also, to provide an institution to which mental cases might be sent from D Block, in order to obviate their transference to public asylums—a policy which was adopted in view of the special circumstances attending the cause of the disorders. The Military Hospital, Maghull, being built upon the villa pattern, provided the requirements of these cases. To meet the increasing number of cases, further institutions were added at later dates to those just mentioned—viz., the Springfield War Hospital, for severe and protracted cases of neurasthenia and "borderline" cases, and the Napsbury War Hospital, for cases of acute mental disorder requiring asylum care and supervision.

As the cases were coming over in considerable numbers, and in order that all cases should receive a short period of rest and treatment on their return from France before being transferred to the most suitable institution for final disposal and treatment, two "clearing" hospitals were established early in 1915. These were:—

(1) *The Neurological Section, Fourth London Territorial General Hospital.*—All neurological[1] cases, labelled as such at the British base hospitals overseas, were transferred to this section. There they received a short probationary course of treatment, with the result that a large number recovered rapidly and in due course were returned for light duty. A certain number, however, were of a more serious and protracted character. These were transferred eventually to one of the hospitals provided for the purpose—viz., the Maghull or the Springfield War Hospitals. In the event of a patient becoming insane, he was transferred to D Block, Netley, or to the Napsbury War Hospital.

(2) *D Block, Netley.*—All cases of acute mental disorder arising in soldiers overseas were transferred to this section. After a short period for observation and discriminatory sifting, the cases were transferred, on the one hand, to Napsbury War Hospital should they be considered of a certifiable character, and to require care and treatment under asylum conditions; on the other hand, to the Maghull or Springfield War Hospitals if of a non-certifiable character, but requiring more care and supervision than could be obtained in a general hospital.

The foregoing is a brief review of the provision for the cases of nervous and mental breakdown up to May, 1915. For some time before this date it had been noticed that a considerable number of neurological cases were coming from overseas directly into central and auxiliary military hospitals scattered throughout the country. Partly in order to meet the needs of these cases and partly in order to provide additional accommodation for the increasing number of cases, the Director-General established neurological sections in all the territorial general hospitals throughout England, Scotland and Wales (May 24, 1915). These sections were officered where possible by physicians specially versed in nervous diseases. The primary object of these sections was to furnish the same probationary course of treatment to the cases on arrival at the territorial general hospitals as was given in the clearing hospitals, and to bring in all cases from the auxiliary hospitals in which suitable or sufficient treatment was not available. Moreover, cases of a serious or protracted nature, or cases requiring

[1] The term "neurological" is used in this paper to refer to *unwounded* cases suffering from neurasthenia, the functional paralyses, hysteria, and the milder psychoses.

supervision of a special character could be transferred from them to the Maghull or Springfield War Hospitals.

With the introduction of neurological sections into the Scottish general territorial hospitals, it was considered advisable that a special hospital should be provided in Scotland. Through the assistance of the Scottish Branch of the Red Cross, this was forthcoming in the Royal Victoria Hospital, Edinburgh, which has continued to provide accommodation for cases of a neurological character.

At the same time a neurological section was formed in the Main Hospital Building, Netley, the chief object of which was to permit of the removal from the convoys arriving at D Block from overseas all cases which the medical officers there considered did not require supervision of a special kind, as some cases had so far recovered on arrival at Netley as to be deemed suitable for treatment in a neurological rather than in a mental section.

In order to understand fully the arrangements existing at the present time for the care and treatment of unwounded soldiers suffering from nervous shock, neurasthenia and mental disorder, let us follow from overseas two or three hypothetical patients to their final destination in this country.

On arrival at one of the British base hospitals abroad, the soldier's condition is investigated by a special medical officer. The patient then is sent to a section of a hospital according as his symptoms are of a neurological or a mental character. Should he be suffering from transitory mental symptoms, which subside rapidly, he is transferred from the mental to the neurological section as soon as it is advisable to do so. In order to meet this class of case, special accommodation is now being provided at the base hospitals overseas, so that the patient may be placed under the most suitable circumstances for rapid recovery. The patients are labelled for transference to one of the clearing hospitals at home: if neurological, to the Fourth London Territorial General Hospital, or the Neurological Section, Netley; if mental, to D Block, Netley.

Neurological Cases.—On arrival at one of the clearing hospitals just mentioned, or at a neurological section in any territorial general hospital, the patient is given treatment. If his symptoms are slight or transitory and disappear rapidly, he is sent on furlough and later is returned to light duty. On the other hand, should the course of the disorder be less favourable, or should symptoms develop which require special supervision, or if it be the opinion of

the medical officers that the case is likely to be protracted or to require special treatment not available in the section, the patient may be transferred to one of the special hospitals for nervous diseases or to a special institution: (*a*) to the Military Hospital, Maghull, for the Northern and Western Commands; (*b*) to the Springfield War Hospital for the Eastern, Southern and Aldershot Commands; and (*c*) to the Royal Victoria Hospital, Edinburgh, for the Scottish Command. If the patient is under treatment at one of the hospitals in the Irish Command, he may be transferred to the King George V Hospital, Dublin.

If for various reasons it has not been possible to send patients home through the clearing hospitals so that they arrive directly from overseas at central or auxiliary military hospitals, in which there is no neurological section, or to which no medical officer with special experience is attached, a short period of treatment is given; but should recovery not take place within two or three weeks, the patient is transferred for treatment to the neurological section of the nearest territorial general hospital.

From the preceding account it is evident that every case of nervous shock and neurasthenia coming from overseas is given a short period of rest and treatment in the hospital at home at which he arrives. In many instances this period is sufficient to permit of recovery. In other cases, sufficient opportunity is provided to study the symptoms with a view to the transference of the patient to one of the special institutions should this further step be necessary.

Mental Cases.—On arrival from overseas at D Block, Netley, the patients are examined by the special medical officers attached to the hospital. All cases which are considered to be of a neurological character are removed for treatment to the neurological section, in the Main Hospital Building, Netley. All patients suffering from the severer psychoses of a certifiable type are given two or three weeks' probationary treatment in D Block. If no recovery has taken place during this time, they are transferred to the Napsbury War Hospital, or to the Dykebar War Hospital, Paisley, if their domicile is in Scotland or if they belong to Scottish regiments.

No mental cases are transferred directly to Ireland, but special arrangements have been made recently by which overseas cases of mental disorder arriving in Ireland may be treated in a villa attached to the Richmond District Asylum.

The number of cases which recover during their stay in D

Block and are returned to light duty is negligible, but a certain number recover sufficiently during their stay there to be no longer considered as of a certifiable character. These latter are transferred to the Red Cross Military Hospital, Maghull, or the Springfield War Hospital for further observation and treatment.

A short account may be given of the institutions to which reference has been made, the general character of the cases retained for treatment and the percentage of cases returned to light duty.

(1) *The Neurological Sections* at the Fourth London Territorial General Hospital and the Royal Victoria Hospital, Netley.

The Neurological Section of the Fourth London General Hospital is the largest of the neurological sections, and in addition to receiving the majority of the neurological cases sent home directly from overseas, it accepts patients transferred from central and auxiliary military hospitals in the London district and adjoining counties. It contains 400 beds. An important division of the section is the Maudsley Hospital, which is especially well adapted for the care and treatment of soldiers suffering from all forms of traumatic neurasthenia, hysteria and the milder psychoses.

The Neurological Section of the Royal Victoria Hospital, Netley, occupies several wards in the main hospital building and consists of about 100 beds. It serves a most useful purpose in taking over for treatment cases which have been sent from overseas to D Block, but which require no longer the special supervision provided there. Cases are sent also directly to the section from overseas.

The type of case observed and treated in these sections is similar. They are: most forms of functional paralysis, especially paraplegia, disturbances of speech and articulation, amnesia (or loss of memory), the effects of terrifying dreams, mutism, deafness, deaf-mutism, amblyopia, "bent-back," tremblings and motor agitations, tic-like movements, sleeplessness, nervous debility, indecision, loss of self-confidence and the milder forms of neurasthenia, simple mental confusion, the anxiety psychoneuroses and simple mental depression.

The treatment adopted consists chiefly of rest and feeding, massage and electrical applications in suitable cases, baths when these seem indicated and psychotherapy in the form of simple suggestion and occasional hypnosis.

In a general way the results of treatment at the Fourth London General Hospital show 40 per cent of cases returned to light duty. Of the total admissions 20 per cent of cases were invalided and 20 per cent are transferred for further treatment to the special institutions.

(2) *The Special Institutions*—The Red Cross Military Hospital, Maghull, and the Springfield War Hospital.—Both these hospitals are constructed on somewhat similar lines, in that they are provided with single rooms and special accommodation for cases requiring isolation and supervision in addition to day rooms and dormitories.

The Maghull Military Hospital had not been used for the treatment of patients before it was taken over by the War Office, but the Springfield War Hospital had been employed as a hospital for defective children for about ten years.

The available accommodation in the two hospitals amounts to about 550 beds. No case is admitted directly from overseas to either of these institutions, as all cases have received a course of treatment at one of the military hospitals at home before transference. The patients most suitable for treatment in these institutions are cases of neurasthenia of a severe or protracted character; the milder psychoses, such as simple melancholia and the anxiety psychoses; psychoses with obsessions and fears; profound amnesia; epilepsy; high-grade mental defectives; the milder types of primary dementia, and all cases of a functional character which do not lend themselves to treatment in a general hospital.

Treatment is conducted upon general lines, rest, feeding, indoor and outdoor recreation, and massage in suitable cases. At the Maghull Military Hospital a form of psycho-analysis has been used with advantage in selected cases. The results of treatment at Maghull show about 40 per cent of cases returned to light duty.

(3) *The Mental Hospitals*—Napsbury War Hospital and Dykebar War Hospital, N.B.—These hospitals receive the majority of their patients from D Block, Netley; but Napsbury admits mental cases also from military hospitals in the Southern Command and the Midland counties; Dykebar admits also from military hospitals in the Scottish Command and the Northern counties. The Napsbury War Hospital is the hospital section of the parent asylum; Dykebar is one of the most recent of the Scottish asylums built upon the villa pattern. The available accommodation in the two hospitals is about 700 beds.

The patients transferred to these hospitals are of a certifiable type and include most of the severe forms of acute mental disorder—the confusional psychoses, mania, the graver melancholias, acute delusional and hallucinatory psychoses, dementia præcox, mental deficiency with confusion, general paralysis of the insane, and epilepsy with mental symptoms.

In accordance with accepted policy, none of the patients in these

hospitals is certified as a person of unsound mind. Each patient is given a reasonable period of treatment with a view to recovery.

In consequence, however, of the accumulation of chronic and incurable cases which was observed a few months ago, it was decided (September 28, 1915) to board and discharge to asylums all cases of general paralysis of the insane, of epilepsy with insanity, and all patients who had been in asylums prior to enlistment. A certain number of chronic cases also are boarded and discharged to asylums if no improvement is recorded after a fair and reasonable period of observation and treatment.

It is obvious from the nature of the disorders that the percentage of cases returned to light duty must be small, but the figures from the Napsbury War Hospital show from 10 to 15 per cent of cases discharged to light duty.

CONTINUED FEVERS OF OBSCURE ORIGIN OCCURRING AMONG THE SOLDIERS OF THE BRITISH FORCES IN GREECE.

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The object of this paper is to call attention to some forms of fever of uncertain origin, treated during the last two months. For convenience of description as well as for the purpose of a classification for clinical work I shall divide the cases into three types.

Type I.

This type is common, about twenty cases being admitted to the hospital during the last month. It is characterized by the commonplace symptoms of infection, such as headache and pain in the back and three outstanding clinical features, namely:—

(1) Continued fever, usually of a mild type.
(2) Enlargement of the spleen.
(3) Slight lymphocytosis.

As a negative characteristic one may also mention that agglutination tests for typhoid and paratyphoid fever A and B, made on various days during the second and third week of the disease, have proved negative. To illustrate the clinical picture I shall give a brief report of three cases.

Case 1.—Private C., aged 25. Four months ago the patient was inoculated (two doses) against typhoid fever. He was taken ill on December 3, 1915, with headache, pain in the back, slight chills, fever, loss of appetite and nausea. Coryza was absent. On the second day of the disease there was slight pain in the abdomen which was relieved by a laxative. Patient was admitted on December 7, four days after the apparent beginning of the disease.

Present conditions: Patient complains of slight headache, weakness and a general feeling of malaise. The dorsum of the tongue is coated with a white fur and the tip and edges are red. The appetite is poor; constipation is present. The spleen is palpable and its consistency increased. Temperature 100° to 102° F. Pulse 75 to 85. Blood culture is negative.

On the following day temperature diminished but the fever

continued at a low level until December 13, the tenth day of the disease. The agglutination tests for paratyphoid fever A and B, were negative on the ninth day of the disease. The agglutination test for typhoid was sensitive at a dilution of 1 in 125. The spleen continued to be palpable until the thirteenth day of the disease. On the fifteenth day of the disease the agglutination tests were repeated with results the same as those of the ninth.

Case 2.—Private John A., aged 19, was inoculated against typhoid (three doses) in April, 1915. He was taken ill on December 24. Complaint : Headache, loss of appetite, nausea, feeling of soreness in various parts of body. On the third day of his illness was admitted to hospital.

Present condition: Temperature 101° to 101·4° F. Pulse 90; white blood corpuscles, 8,400. Differential count: Large mononuclears, 9·8 per cent; lymphocytes, 38·8; polynuclear neutrophiles, 45 per cent; eosinophiles, 4 per cent; basophiles 0·8 per cent; undetermined, 1·6 per cent. Liver and spleen palpable. Other organs normal.

December 31, agglutination tests.—Typhoid negative; paratyphoid A and B, negative.. Temperature normal; spleen palpable.

January 3.—Temperature continues to be normal. Spleen still palpable.

January 6.—The agglutination tests gave the same results as on December 31. Spleen not palpable, but physical signs indicate that it is enlarged.

Case 3.—Corporal Robert A. S., aged 22, admitted to hospital December 25, 1915. Patient was inoculated (two doses) against typhoid. Four weeks ago had an attack of diarrhœa. On December 24, one day before the date of admission, began to suffer from headache and soreness in various parts of the body, pain in the abdomen, and slight soreness of the throat.

Present conditions: December 26, patient complains of headache and pain in various parts of body. Face is flushed; tongue is covered with a white fur; temperature 100° to 102° F.; white blood corpuscles, 8,600.

January 2.—White blood corpuscles, 10,200; temperature 99° to 101° F. There has been a continuous fever since date of admission. Spleen is palpable.

January 7.—Agglutination tests: Typhoid fever, 1 in 100; paratyphoid A and B negative. No bacteria of enteric type found in stool.

January 8.—White blood corpuscles, 9,200. Differential count: Large mononuclear, 12 per cent; lymphocytes, 29 per cent; polynuclear neutrophiles, 55 per cent; eosinophiles, 2 per cent; basophiles, 0·8 per cent; mast cells, 1 per cent; transition, 1 per cent.

January 9.—Spleen diminished in size.

January 14.—Agglutination tests the same as on January 7.

The morbid condition invariably begins abruptly with pain in head, back, and other parts of the body. Nausea is common, and when present is not infrequently followed by vomiting. The appetite is generally diminished. The dorsum of the tongue is covered with a white fur, and frequently the tip and edges are red. In many cases there is abdominal pain in the early stages of the disease, but diarrhœa is not a common manifestation. On the fourth or fifth day of the disease the spleen as a rule becomes palpable. The hardness of the spleen is about of the same degree as that of paratyphoid fever. Some of the patients complain of pain in the region of the spleen. This may be due to distension of the capsule of the viscus or to perisplenitis. The spleen remains enlarged during the course of fever, and in some cases the enlargement continued for several days after the temperature became normal.

The fever is of the continued type, with considerable daily remissions. The maximum temperature is not higher than 103° F. The morning temperature is usually below 100° F. The course of the fever is from six to fourteen days. There have been no relapses in this type of fever.

An examination of the blood after the first few days of the fever shows a relative increase of the lymphocytes. The number of leucocytes varies from 8,000 to 16,000.

It is evident from the study of the symptomatology which we have given that the nature of these fevers is obscure. The blood count, the bacteriological and serological tests exclude, we think, typhoid fever and paratyphoid fever A and B. The clinical picture is also different from that of influenza.

The fevers of this type exhibit a very close resemblance to paratyphoid fever. In paratyphoid, as in these fevers of obscure origin, there is frequently a sudden onset; abdominal pain is a common symptom in the early stages, and the spleen is enlarged and exhibits a considerable degree of hardness. There are, however, three characteristics of the fevers of Type 1, which exclude paratyphoid fever A and B. These are:—

(1) The presence of a slight leucocytosis (in paratyphoid fever A and B, leucopenia is a common manifestation).

(2) The short duration of the fever, six to fourteen days.

(3) Agglutination tests negative on various days during the second and third week after the beginning of the fever.

Type II.

The essential characteristic of this form is the presence of leucopenia or normal blood count. We have notes of only four cases of this type. According to these reports the symptomatology is somewhat variable. In two the fever began suddenly, in the other two insidiously. In the latter eosinophilia was present—the blood count in one being 4,200 with 8 per cent of eosinophiles and in the other 6,500 with 9 per cent eosinophiles. Differential counts were not made in the other cases. In the two characterized by eosinophilia the fever was low grade—the temperature frequently being normal in the morning. The spleen was not enlarged in either of these cases. In one the duration of the fever was two weeks; in the other the fever had not disappeared at the end of four weeks. In the latter case a blood count made at the end of the fourth week showed 7,500 white blood corpuscles and 4 per cent eosinophiles. The presence of eosinophilia in these cases was of diagnostic value as it excludes typhoid and paratyphoid fever.

Type III.

These fevers are about as common in our hospital as those of Type I. In the symptom complex of this type there are two essential symptoms.

(1) Neutrophilic leucocytosis, at least in early stages of the fever. In the later stages lymphocytosis is frequently present.

(2) Fever of a continued, intermittent or relapsing type and frequently of long duration.

In many cases the onset of this type is sudden and characterized by headache, pain in limbs, chilliness, fever and general malaise. The clinical picture at this stage may suggest the presence of influenza. In four cases the illness began with symptoms of dysentery. Case 3 of this type is one of these. This suggests that possibly some of these fevers are general infections caused by bacilli of the dysenteric group. As the dysenteries are believed to be general infections caused by various forms of bacilli (Shiga,

Flexner, Y, etc.), it is not improbable that one may produce a clinical picture such as described in Case 3.

The duration of the fever is very variable. In some cases the fever is of long duration (four to six weeks). In the course of the fever, intervals during which the temperature is normal are common. These afrebile periods alternating with periods of fever may suggest the presence of relapsing fever (see fig. 1). There is, however, generally a want of regularity in the temperature curve. Moreover, the spirillum of relapsing fever has not been found, although looked for in several cases. The blood picture is, we think, somewhat distinctive. In the early stage there is present a neutrophilic leucocytosis with a blood count of 10,000 to 20,000. In the later stages the neutrophilic leucocytosis may be replaced by a lymphocytosis. An interesting feature about the cases with a relapsing form of fever is that a slight leucocytosis may be present during the afebrile period. With the onset of an attack, however, the blood count is increased.

The condition of the spleen is variable. In several cases of fever of long duration there was no evidence of enlargement, in others it was enlarged but never to the same degree as that of cases of Type I.

To illustrate the clinical pictures exhibited by these fevers I shall report briefly the clinical records of three cases.

Case 1.—Corporal P. was taken ill on December 12, 1915, with headaches, sensation of chilliness and pains behind the eyes. His affection was diagnosed as influenza. After five days his fever disappeared. On December 19, the seventh day of his illness, he was transferred to hospital. On the day of admission his temperature was normal; spleen palpable. His temperature continued to be normal till December 30, when it quickly rose to 108° F. With the rise of temperature he suffered from symptoms similar to those of the first attack. White blood corpuscles, 19,000. Differential count showed the presence of neutrophilic leucocytosis. On January 3 the leucocyte count was 13,000. The temperature became normal on January 5, 1916, and a few days later the enlargement of the spleen disappeared.

Case 2.—Private B. was taken ill on December 13, 1915, with fever, headache (frontal), pain in limbs and general malaise. On the same day he was admitted to hospital. Two days later his temperature was normal. On the fifth day of his illness his temperature rose again and the patient suffered from the same symptoms as in the first attack of fever. He was transferred to a

general hospital on the following morning, the sixth day of his illness. His temperature was then normal. He was pale and weak but otherwise felt well. Spleen was not palpable. Five days later his temperature rose abruptly to 103° F. There was no chill. Leucocyte count 14,600. Differential count showed neutrophilic leucocytosis (polymorpho-nuclears) 78 per cent. On the following day his temperature was normal. Since then there have been three relapses at intervals of six and seven days. During the attacks of fever the blood has been repeatedly examined, special attention being directed to the detection of the organism of malaria and relapsing fever.

Blood counts: December 31—white blood corpuscles, 12,000; January 3—white blood corpuscles, 14,000; January 15—white blood corpuscles, 8,600.

Differential count (January 15): Polymorphonuclear, 50 per cent; large mononuclear, 11 per cent; lymphocytes, 30 per cent; eosin, 4 per cent.

The course of the temperature is illustrated in fig. 1. On December 31, thirty-five grains of quinine sulphate per diem were administered without materially altering the course of the fever.

Case 3.—Private B. was taken suddenly ill on December 22, 1915, with pain in the abdomen, diarrhœa, and tenesmus. There was no blood in the stools. On the same day he was admitted to hospital. Temperature 99·3° F. On December 26 the diarrhœa was much better but the patient complained of pain in the right inguinal region. There was some rigidity and tenderness in the region of the cæcum. There was no vomiting and the bowels were regular. White blood corpuscles, 8,000. On January 7 temperature began to rise. White blood corpuscles, 10,000: polymorphonuclear, 79 per cent. Patient still complains of slight pain in the region of the cæcum. Spleen not palpable.

January 12.—Since January 7 the temperature has continued with frequent remissions and intermissions. Spleen is not palpable. White blood corpuscles, 10,400. The course of the temperature is illustrated in fig. 2.

Remarks on the Origin of the Fevers.

In speculating as to the nature of the fevers, I shall limit my remarks to a brief discussion of the probable causative agents.

The probable causative agents of the fevers of Type I and Type II are, I think, contaminated water and food. My reasons for holding this view are:—

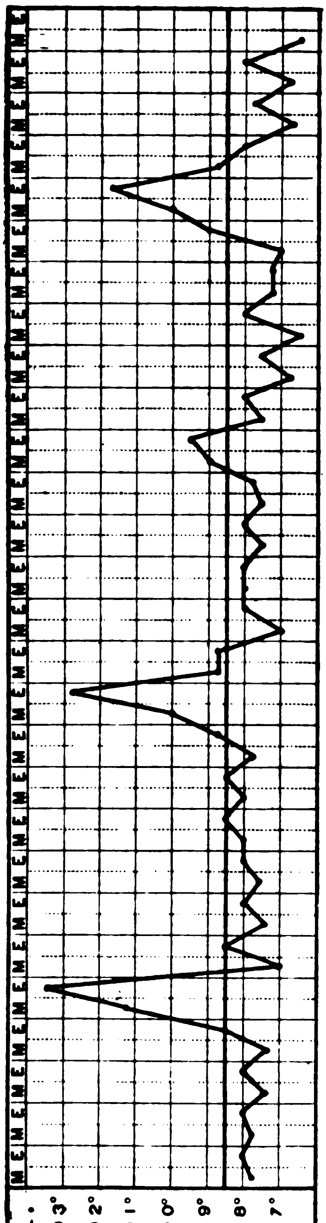

Fig. 1.

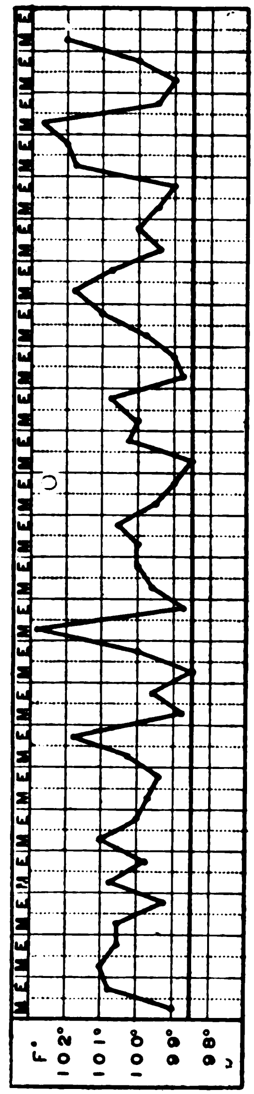

Fig. 2.

(1) The fevers resemble typhoid and paratyphoid fever in many of their characteristics, and (2) disorders caused by contaminated water and food are very common among immigrants to this country.

It is well known that the so-called food poisoning is common among immigrants in Macedonia, Egypt, and other countries in which little attention is given to preventive medicine. In order to preserve health an immigrant must be very careful in the selection of a dietary, especially during hot weather. Any uncooked food-stuff which may be contaminated by flies or through want of cleanliness on the part of the natives is to be avoided. Milk produced from cows or goats frequently contains pathogenic bacteria and, therefore, should not be used in the uncooked condition. The same care should be exercised with regard to other food-stuffs. In order to be safe from infection most food-stuffs produced in the country must be well cooked.

An interesting feature about this food poisoning is that the natives are less susceptible than immigrants. The reason why this is the case is probably that the native population is more or less immunized to many bacterial infections conveyed by diseased food. This fact has a bearing on the origin of the fevers under consideration in the paper. If, for instance, a soldier sees a native drinking water from a stream, he is apt to think that it is safe for him to do the same. This condition of affairs is principally due, I believe, to want of instructions on personal hygiene and preventive medicine among the soldiers.

In order to make clear what is meant by the term, food-poisoning, I shall, in this connexion, briefly discuss the subject.

Practically all cases of the so-called food poisoning are acute infections due to the presence and activity of micro-organisms. These belong to either the paratyphoid or hog cholera group, that is to say, they extend from the typhoid bacillus at the one end to the colon bacillus at the other. There are many intermediate forms in this group, though there are missing links in the chain. Thus there are the paratyphoid bacilli, the organisms of Brion and Kaiser—*paratyphosus* A and *paratyphosus* B—the bacilli of the dysenteries, the hog cholera bacillus (*Bacillus choleræ suis* of Salmon and Smith), the *B. psittacosis*, the *B. icteroides*, the *B. typhi murium*, *B. enteritidis* of Gaertner, the *B. paracoloni* of Burton, and the *B. pseudotuberculosis rodentium* of Pfeiffer, besides others. Under certain conditions, or in overwhelming numbers, a number of these bacteria are capable of producing gastro-intestinal disturbances or general infections.

The sources of these bacteria are such animals as suffer during life with puerperal fever, uterine inflammations, navel infections (in calves), septicæmia, pyæmia, diarrhœa, and also from local suppurations; or from meat or other food-stuff which has become contaminated by flies or by carriers of the germs.

F. A. Bainbridge, in the Milroy Lectures on Paratyphoid and Meat Poisoning, considered these as distinct diseases caused by different bacilli, yet closely related. Paratyphoid fever is caused by *B. paratyphosus* A and B. Meat poisoning he regarded as caused by the *B. enteritidis* of Gaertner, or *B. choleræ suis*. The former infection resembles typhoid fever; the latter an acute gastro-enteritis. It is the meat of cows and calves which is most often responsible for meat poisoning, mutton having never been convicted, and the pig in only one outbreak.

It is probable that the classification of Bainbridge will not bear the test of future clinical and bacteriological investigation. There are probably micro-organisms in the typho-colon group other than the *B. typhosus* and the *B. paratyphosus* A and B, which may cause continued fevers, such as those of Types I and II under discussion in this paper; also other animate agents of poisonous meat than the bacillus of Gaertner and the bacillus of hog cholera, which may cause gastro-enteritis. Moreover, germs such as the bacillus of Gaertner and the *B. choleræ suis*, which usually give rise to a complex of symptoms which is designated gastro-enteritis, may sometimes produce a continued fever and other symptoms more or less similar to those of typhoid fever.

The origin of the fevers of the Type III appear to be even more obscure than those of Types I and II. In discussing the characteristics of the fevers of Type III, attention was called to the possibility of some of the fevers being general infections caused by a bacillus of the dysenteric group.

Clinical and other Notes.

A NOTE UPON THE EMPLOYMENT OF BLOOD TRANSFUSION IN WAR SURGERY.

By Major EDWARD ARCHIBALD.
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It can now hardly be gainsaid that the transfusion of blood, whether by the direct or the indirect method, is a procedure which, in certain circumstances, turns the scale and is absolutely life-saving; and in this War, it would seem, a priori, that the indications for using transfusion ought to present themselves not infrequently. It is fairly certain that the method finds its clearest indication and secures its best results in cases of uncomplicated hæmorrhage. Now it may be urged that the cases of uncomplicated hæmorrhage are rare; that severe shock is frequently coexistent; as that, in other cases, serious infection, or multiple visceral injuries or injuries to the thorax are present, all of such a nature as to render any raising of blood-pressure inadvisable, or to forbid operation, or to make nugatory even the success of a possible operation. Such considerations have a very definite weight. Yet, to judge from my own experience, I cannot but conclude that there exists a fair residue of cases in which transfusion promises much. That at least is my conclusion in regard to the secondary hæmorrhage so common in Base Hospitals; as for the emergencies seen in Casualty Clearing Hospitals near the Front, especially the hæmorrhages from injuries to the extremities and the abdomen, my experience is yet too small to justify anything more than the mere suggestion that transfusion is worthy of trial.

Hitherto, in the literature of the War, I have not come across any published record of work along this line. It is altogether likely that such work has been done. If so, these remarks may serve a useful purpose in stimulating discussion; for I am convinced that the method deserves both trial and discussion.

It is perhaps legitimate to suppose that the transfusion of blood would long since have been widely employed in work at Casualty Clearing Stations had not the impression prevailed that the technique demanded too much, in time and in skill, of the surgical specialist; and also possibly that the donors might be difficult to get, or that, on the other hand, preliminary hæmolysis tests, difficult and time-consuming, were necessary. All of these fears, are, I think, groundless. As to donors, I have found not the slightest difficulty in securing a volunteer from among the very slightly wounded, those who are to be returned to duty within the week. The

danger from hæmolysis is minimal, and can be disregarded in a matter of such urgency. Finally, as to the technique, it is now abundantly proven that the earlier methods of Crile and of Carrel, involving direct suture of vessel to vessel, are unnecessary, and that the easier indirect methods are not only sufficient, but possess the advantage of giving an exact measurement of the amount of blood transferred.

My own preference before the War was for the Kimpton tube, and we brought over six of these from Canada. They have been used five times in four cases, and have been most satisfactory in making the procedure easy. On the other hand they labour under certain disadvantages in so far as the Army's needs are concerned, and particularly so at the Front. They have to be coated with sterile hard paraffin on the inside before each time of using, and they are not on this side of the water immediately obtainable; while, being made of glass, they are apt to break.

There is, however, another method, the citrate method, recently brought forward, which seems to me peculiarly suited for easy adoption in Army work. Indeed, the chief purpose of these remarks is to call attention to the fact that we have in the citrate method a means of transfusing blood so simple that it can be done by a junior medical officer with the instruments at hand in any Clearing Hospital, and in the same time that it takes to give an intravenous saline. The principle is old. It depends upon the use of a solution of sodium citrate to prevent clotting. But its application to blood transfusion, and the experimental working out of the necessary safeguards for its use in the human, are rather new. The subject is ably reviewed in an article by Lewissohn, in the July number, 1915, of *Surgery, Gynæcology and Obstetrics*. The procedure consists, briefly, in doing a venesection, collecting the blood in a glass graduate in which has been placed a measured quantity of sodium citrate solution, and injecting this blood into the exposed vein of the recipient. I have used the method only four times so far, myself, and it has gone perfectly. On the first occasion I exposed the vein of the donor, under novocain; inserted the end of an ordinary glass medicine-dropper into the distal end of the vein, a bandage having been tied round the arm above; and allowed the blood to flow, which it did freely, into a glass vessel, until 17 ounces were collected. An assistant held the vessel, in which 1½ drams of a 10 per cent solution of sodium citrate in distilled water had been previously placed, and stirred constantly with a glass rod. After 8 ounces had been taken, a further 1½ drams of the solution were added, that being the proportion of citrate advised for each quantity of 8 ounces. (The original recommendation is 5 cubic centimetres of a 10 per cent solution of sodium citrate to 250 cubic centimetres of blood; or 30 cubic centimetres of a 2 per cent solution to 300 cubic centimetres of blood.) Thereupon, the vein of the recipient being exposed, and an ordinary cannula provided with a short piece of rubber tubing being inserted, the blood was injected with an ordinary

4-ounce glass syringe. There would appear to be no danger of clotting. Nothing could be more simple. One can deal with the blood as one would deal with saline. On subsequent occasions I avoided incising to expose the vein, and merely plunged a large-sized needle (from the Potain aspirator) into the distended vein, as one takes a blood culture.

The value of transfusion, judging from one's own observations, lies chiefly in the quick supply of oxygen to the cells of the exsanguinated person. It is remarkable to see the immediate return of colour in the face of the blanched patient; and, moreover, it is now generally admitted that the transfused red cells remain alive and carry on normal function.

We are yet naturally uncertain as to the results. Undoubtedly the procedure if extensively tried at the Front, as I venture to recommend, will in many cases accomplish nothing, or too little. We have to consider above all the coincidence of shock, for which, as has been shown recently by Libmann and Ottenberg, transfusion of blood is of little, if any, value. The recent work on shock seems to prove clearly enough that that condition is due to no primary loss of power in the vasomotor centre, nor to lack of blood, but rather to the displacement of a critical amount of blood from the arterial to the venous side of the circulation and its retention to a large extent on that side. Consequently a transfusion of blood may do no more good than the infusion of an equal quantity of saline, and often enough neither could work any lasting benefit. On the other hand, cases of shock complicated by severe hæmorrhage might be tided over by a transfusion of blood and recover from their shock when they otherwise would not.

Where a severe infection is present, particularly if it has become a septicæmia, one can hardly expect often to save life by a transfusion. One of my cases, with gas gangrene of the thigh, exsanguinated and in very bad general condition, was sufficiently improved by a transfusion to stand an amputation in the upper third; but he died a day later from extension of his infection. Such a type of case would yield many disappointments. It might be questionable, also, whether a very large effusion of blood into the thorax should indicate a transfusion. Probably not, as such patients so rarely die of hæmorrhage pure and simple. At most one might do it with coincident aspiration of blood from the thorax and insufflation of oxygen for compression of the lung, as we did at base after the lapse of a week or so. With regard to the abdominal cases, in which so often operation discloses a belly full of blood, I entertained, from a priori considerations, high hopes that tranfusion would save many lives. But with observation of the cases of others, and of post-mortems and with the study of my own cases (at present numbering only some thirty-five it should be said) I have become gradually impressed with the belief that shock kills more often than pure hæmorrhage; and that, even when a considerable amount of blood is found in the cavity, the later death, if it occurs, is often more directly the result of the shock

than of the loss of blood. It falls to be said that some of those with whom I have discussed this question, whose experience is much greater than my own, maintain that hæmorrhage, rather than shock, is the great cause of death in the first day or two after an abdominal wound. If their opinion is correct, transfusion is all the more indicated. If not, transfusion is still indicated, but disappointments must be expected. And in either case, if we are to diminish the still high mortality of the abdominal cases, transfusion, I think, is the first and most promising means that demands trial.

I append a short synopsis of the cases of transfusion of blood and with which I have had to do. Four transfusions in three patients were done last autumn in a general hospital, all at the base, for secondary hæmorrhage of very severe degree. Of these, two were done by myself and two by a colleague (Major Hill), who kindly allows me to use his notes. Finally, five more have been done in a Clearing Hospital at the Front within the last three months.

Case 1.—Very extensive foul shell wound, tearing through the posterior thigh muscles. About the eighth day a hæmorrhage of moderate severity occurred, controlled by packing. Three days later a second and very grave hæmorrhage, leaving the patient almost pulseless. Intravenous saline was given, which did but little good. Under anæsthetic, impossible to find bleeding point, because of cessation of bleeding. Pulse disappeared entirely on the table, and patient was apparently *in extremis*, whereupon 250 cubic centimetres of blood were transfused. The effect was quite remarkable. Some colour reappeared in cheeks and ears, and the pulse was restored. He rallied well, but ran a very high temperature for a week (103° F. to 105° F.), which was ultimately found to be due to a streptococcus septicæmia. Then he had a third slight hæmorrhage easily controlled, and on the following day a fourth severe one. He was again reduced to an almost pulseless condition, was blanched, and was quite lethargic. An intravenous saline of nearly two pints did not alter his condition a whit; but a transfusion of 700 cubic centimetres of blood an hour later worked a most remarkable change. Some colour returned immediately; his pulse grew fairly strong though rapid; he became bright again and demanded things with all of his former irritability; and in fact one could hope with some reason that he would pull through. Unfortunately, during the night he had a fifth small hæmorrhage, became extremely restless, and died some twenty hours after the last transfusion, largely from hæmorrhage, partly from sepsis. Post-mortem showed a tear in the profunda femoris. It had never been possible to catch it bleeding.

Case 2.—A severe shell wound of the right buttock, penetrating the pelvis, with small tear of the rectum. Early development of gas gangrene, or at least of gas, under the buttock muscles, spreading rapidly down under the deep fascia to the popliteal space, where it was first detected.

Very extensive incision from buttock to knee laying open the whole region and baring the sciatic nerve. Improvement for several days. Then a moderate secondary hæmorrhage which ceased spontaneously; this occurred at 5 p.m. At midnight a second and severe hæmorrhage which left him practically pulseless. Transfusion of 500 cubic centimetres of blood, following an intravenous of thirty-five ounces saline, which had done absolutely no good. The blood worked the same remarkable change for the better as was described in the first case. But at 5 a.m. a third bad hæmorrhage carried him off before help could be given. At no time, not even at post-mortem, could the point of bleeding in the vast wound be discovered. It was probably inside the pelvis.

Case 3.—A boy, with a shell wound in the shoulder, the fragment having gone right through the deltoid inwards; there had been very little infection, and the wound was healing well, when nearly three weeks after the injury he had a most severe hæmorrhage. On the operating table he was quite pulseless, and absolutely blanched. An intravenous saline did no good. A transfusion of 750 cubic centimetres of blood was then done, with the same gratifying results. The wound was then opened, and an opening in the terminal portion of the axillary artery found. The artery was ligatured. The boy made a splendid recovery, and in about ten or twelve days was discharged to England. It is tragic to relate that he was one of those who went down in the "Anglia."

The following five cases occurred in a Casualty Clearing Hospital:—

Case 4.—An extensive shell wound of the upper thigh, tearing away part of the adductors, and of the quadriceps, and two inches of the femoral artery just below the apex of Scarpa's triangle. The femoral vein was not torn, but was thrombosed over three inches of its course. The foot was warm, though the pulse could not be felt. He had bled a great deal. Condition was desperate; but an intravenous saline improved it sufficiently to allow an exploration of the wound under local anæsthesia, at which the details of the above description were made out. Amputation seemed too risky then. The next morning, twenty-four hours after admission, gangrene of the toes was beginning to show, and also gas gangrene of the muscles in the open wound. Amputation imposed itself; but his pulse and his general condition were extremely bad. A transfusion of sixteen ounces blood, taken from a volunteer patient in the ward, was performed. It was sufficient to change a very bad operative risk into a reasonable one, and a flapless amputation in the upper third was done which the patient stood very well. He died in about twenty-four hours, however, from extension of the gas gangrene.

Case 5.—Wound of abdomen from fragment of shell. Admitted at 3.30 p.m., having been hit two or three hours previously. He was very pale; the pulse was 76 and very weak. His blood-pressure was 75 systolic and 55 diastolic (Tyco's instrument). He was in great pain,

and was obviously suffering from severe shock. The wound of entry was in the mid left rectus, two inches above the umbilicus, and the missile could be felt under the skin in the right loin posteriorly. Operation was begun at 4 p.m. There was found a large amount of blood in the pelvis and in both flanks. The root of the mesentery in its upper part was infiltrated with blood. The missile had perforated both walls of the stomach near the greater curvature. Bleeding seemed to have stopped, and its source could not be determined, but was thought to be from the gastric vessels. The tears were sutured, and at the close of the operation he was given seventeen ounces of blood to which had been added five drachms of a ten per cent solution of sodium citrate, in the manner already described. During the operation the patient had become pulseless. The blood transfused made his pulse palpable, and indeed sufficiently so to give one hope that he would rally. Yet it did not restore his colour to any noticeable extent. After this temporary improvement which lasted some three or four hours, his pulse failed rapidly, and he died at midnight at about twelve hours after being hit, and seven hours after operation. At post-mortem it was found that no fresh bleeding of any extent had occurred. A wound of the second portion of the duodenum on its postero-lateral surface and a ragged perforation of the lower pole of the right kidney, without injury to the renal vessels, had been overlooked at the operation. It seemed reasonable to conclude that the cause of death, while in part hæmorrhage, was largely shock. The total amount of blood lost did not by itself appear to be sufficient to account for death.

Case 6.—Admitted April 5, 1916, at 7.30 p.m. Was hit about 2.30 p.m. by fragment from a high explosive. Wound of entry in arm at lower border of axilla; wound of exit on outer aspect over rotundity of deltoid. He lost on the road back to the field ambulance a lot of blood, and again a great deal during the ride into the clearing hospital. On arrival, he had a sighing respiration, his mucous membranes were absolutely white; he was very cold; he had an involuntary movement of the bowels; neither radial nor brachial pulse could be felt in either arm. An intravenous saline of forty-five ounces was given immediately; after which his blood-pressure was taken and found to be 70 systolic and 50 diastolic, although to palpation the pulse was still unobtainable, and he was still lethargic. Blood-pressure measurements have all been taken by auscultation. Consequently, it was decided to give him citrated blood, which was done about 9 p.m. After not more than two ounces had been injected, he half raised his head, made a sort of inarticulate noise, and seemed to be in momentary distress of some kind: turned his head to the right, and, as was found by touching the cornea, became unconscious. The injection was immediately stopped; and within five minutes he awoke, became as before, answered questions slowly and as if very tired, but quite rationally, and was found to have no sense (either

then or later) of what had happened. Presumbably, it was one of the rare accidents due to isoagglutinins, known to occur with blood transfusion.

About midnight, as he still remained pulseless, he was given a second intravenous of saline, but this time with gelatine, which we have found holds the pulse up much longer than the saline alone (twenty-five grammes of gelatine, specially sterilized, to thirty-two ounces saline). This gave him a pulse which was maintained from that time on, though for the next day it was only just palpable. In forty-eight hours from the time of being hit, his arm was gangrenous up to near the shoulder and contained gas, which also invaded the tissues towards the scapula and over to the sternum. An exarticulation at the shoulder-joint was done, and free incisions made in the pectoral and scapular regions. A day later, gangrene had invaded the infra spinatus muscle, and this was cut out under novocain. He then made a steady recovery and was discharged to base on April 18.

Case 7.—Admitted at 8.45 a.m. April 6, 1916, suffering from very extensive wounds of the left knee, the right foot and the right thigh. He had lost a great deal of blood and was also in shock, with pulse a mere flicker, running 140 approximately, and blood-pressure 45 systolic, diastolic being unobtainable. Rectal saline with coffee and brandy failed to improve his condition. An intravenous saline with gelatine given at 1.30 p.m. brought his blood-pressure up to 85 systolic and 45 diastolic At 3 p.m. his systolic pressure was 75: and at 4 p.m. it was 72, while diastolic was 60.

At 4.30 p.m. the left leg was amputated above the condyles; and the vast wound in the middle of the right thigh was cleaned by cutting away all necrotic muscle. It was badly fouled with straw and soil. At the close of the operation, the pulse had disappeared at the wrist, respirations were rapid, and he was very pale. The citrated blood obtained the night before for Case 6 had been preserved; and this was now injected into this patient's vein, about sixteen ounces in all. It brought back quite a pink colour to the face and restored the pulse which was counted to 130. He rallied fairly well and one felt able to hope for recovery, but gas gangrene declared itself the next afternoon in the right leg and advanced so rapidly that operation was out of the question. He died at 6.10 a.m. on April 8, about forty-eight hours after the injury.

Case 8.—Admitted 12.5 a.m., April 16. Large shell wound of the left buttock. He was clearly suffering both from shock and hæmorrhage. He had been wounded during the previous evening. He was very cold. The thermometer would not register above 92°. He was quite pulseless in radials, brachials, and even carotids. His blood-pressure could only be got by auscultation; the sounds were just heard at 50, very faint, and disappeared entirely at 40. Respiration sighing; and pulse counted with the stethoscope was 116. He was lethargic, but was deeply under morphia. In spite of whisky and hot drinks and plenty of artificial heat,

he did not improve. At 2 a.m. his blood-pressure had sunk to 40 systolic and 28 diastolic. At 2.30 a.m. he was given fifty ounces of saline intravenously, and his blood-pressure rose to 78 systolic and 40 diastolic, the pulse becoming perceptible. The pulse disappeared again, however, in less than two hours. At 5.30 a.m. he was given sixteen ounces of citrated blood, and Esmarchs were applied to the right leg and to both arms. Upon this the pulse returned, though very feeble and flickering, but some colour was restored to lips and ears and he became much more alive. The corneal reflexes, which were before practically abolished, became active. He spoke, and soon complained of pain from the Esmarchs, which were removed from the arms at 6.40 a.m. He then failed rapidly again, and died at 7.15 a.m.

The post-mortem showed a large ragged wound of the left buttock, widely disorganized gluteal muscles, extensive comminution of the wings of the ilium; retro-peritoneal hæmorrhage behind rectum, sigmoid, and whole left side as far up as the level of the spleen, and across to near the mid-line, but without perforation of the peritoneal cavity. The lungs were full of blood and œdematous fluid, though one could hardly speak of an acute œdema of the lungs; and the right heart was dilated, and contained, with the auricle and great veins, a fair quantity of blood; while the left ventricle was firmly contracted in systole, and aorta was empty. The blood emptied from right heart did not clot and retained a reddish tinge; and it was thought to be probably part of the transfused blood. The liver was a bit pale, but the heart muscle was normally red and firm. This seemed to prove that the patient was not exsanguinated, and had died chiefly from shock.

Of the eight patients, therefore, one was saved by transfusion; and one recovered after alarming symptoms due probably to isoagglutinins in the donor's blood, in spite, therefore, of the transfusion. Our efforts in the other six patients were defeated, twice by the repetition of hæmorrhages with the coincidence of sepsis; twice by gas gangrene; and twice by the preponderating effect of shock. Only desperate cases have been chosen.

It may be urged that sixteen ounces is an insufficient quantity to transfuse. This may be so. Yet I cannot but think that a pint of fresh blood ought to be sufficient to tide a man over the immediate danger of a large hæmorrhage, as indeed it clearly did in certain of our patients. If severe sepsis and shock complicate the picture, it is doubtful whether a larger quantity of blood would accomplish more.

In the first three patients, those with secondary hæmorrhage, treated at the base, the blood was given by the medical officers, who were keen to volunteer. It was found that the withdrawal of sixteen ounces affected them not at all. Twice, however, twenty and twenty-four ounces were taken, and then the officers concerned did experience for a couple of days a feeling of lassitude and easy fatigue, although neither was obliged to go

to bed or even give up his service. At the Front, the volunteers for the four transfusions were got without the least trouble. There will always be more than enough men willing to give blood for the sake of a badly wounded soldier. The question, of course, has a military side to it. Will the volunteer be disabled from duty? The answer from the medical side can, in my opinion, be a reassuring one. The withdrawal of sixteen ounces or even of twenty ounces should not lessen a man's physical capacity for more than two or three days. If one draws from the class of slightly wounded, who are kept in the hospital in the expectation of sending them back to duty in a week, as was done with the first two, there will be ample margin for complete recovery, and the requirements of the military will be satisfied. It should be said that one of the volunteers was sent down to the base for a short rest by the medical officer in charge because he complained of attacks of faintness some days after the transfusion, whereas he had not made the complaint at first. This, I thought, was obviously functional. If, however, a week's leave were allowed to volunteers as a sort of reward, the total loss of time to the military would be very small, and we would hear nothing of any such functional complaints. The last two chosen were "liers" who were going to base next day. One had a sprained ankle; the other had loose internal semilunar cartilage. This is, perhaps, the better plan, to choose such as are going to base next day, rather than the slightly wounded who are to be kept for return to their units in a week.

DIRECT TRANSFUSION OF BLOOD.

By Lieutenant A. GALBRAITH FAULDS,
Royal Army Medical Corps.

"The cures of to-day oft fade by the morrow,
Thus humanity keeps its pain and its sorrow."

If ever poet's words were appropriate to a subject, these certainly are regarding the history of transfusion of blood. The story of this mode of treatment forms one of the most interesting tales in medicine if we had the time to relate it. Commencing evidently thousands and thousands of years ago, it has "faded oft by the morrow," only again to be revived in other forms. The subject becomes interesting and most important at the present time to the surgeons and the physicians who have been called to give their services and experience to the treatment of His Majesty's Forces.

Had it not been for some of my colleagues inviting me to put on record my experience, method, apparatus, and results in direct transfusion of blood, I would not at this time have ventured to write this short paper on the subject. I think if those engaged like myself in

military work will read the following remarks on this increasingly important subject by one who has practised it for many years, I am sure many will benefit not only in judging when to resort to transfusion, the best way of doing it, but what to expect from it. I am also certain that if they follow my advice and my technique, they will not be disappointed in their results. I do not claim any originality, not even in presenting my own simple apparatus. In this little brochure I will also mention how an unnecessary number of danger signals have been hoisted by writers on "Direct Transfusion of Blood," warnings against disasters to donor and patient, disasters which could not happen unless through utter incompetency and crass carelessness on the part of the operator.

Transfusion of blood from animals to men, from man to man, and from animals to animals (chiefly experimental) seems to have been practised from the very early ages. There are said to be references to it in early Chinese and Egyptian times many thousands of years ago, so that like electricity it has taken many ages to come *to light* with its many adaptations and perfections. Long ago transfusion of blood was done for the cure of disease by bleeding animals and injecting a water solution of it into the patient or victim. This, like many other things, fell into disfavour, and was viewed as a crime at one time, only later to be resurrected with the swing of the pendulum, and brought into prominence as a great cure for some fell disease. We read of it taking an important place in medical matters and discussions in Harvey's time, meeting dire opposition by the Faculty of Medicine of Paris, which did not recognize Harvey's discovery and teachings. This opposition was only temporary, for very soon afterwards that body was among the pioneers of this ancient and classic procedure. Then time and again it seems to have "lumed" to fade once more in the horizon of fads and fashions. But within the last quarter of a century direct transfusion of blood has taken its proper place in the surgical work, and will, I am convinced, not now fade, but consolidate its utility in the archives of succeeding generations.

At the present time we have a great advance made by "transfusion," and a magnificent exposure of the benefits of "medicated transfusion" by Ehrlich.

I leave the subject of medicated transfusion which I see practised by some of my colleagues to report on and proceed to the consideration of direct transfusion of blood.

I may say I have never until the War broke out done "direct transfusion of blood" for the treatment of anything but collapse from hæmorrhage, and, like many other surgeons, can tell of the numerous cases where it has been the means of saving the patient's life. But in the work with the unfortunate wounded, surgeons have to deal with cases which require surgical procedure, and who are at the same time unfit to undergo or to recover from anything of the kind.

In such cases a reminder of the value of direct transfusion of blood

will not be unwelcomed. Such cases are in all hospitals, soldiers suffering from the results of great hæmorrhage, and who have been unable from various causes to recover; patients with ununited fractures through a vitiated blood from dysentery; conditions brought about by a long sepsis and where septic wounds will not granulate. Cases of frost bite which will not discard the necrosed parts from not only the vital depression that is concomitant to many of these cases, but owing to the exhausting attacks of malaria, and, in fact, all such cases of "disappointing repair," where the much lauded tonic has been tried and failed, and even the beneficial beverage of a bottle of stout or beer at dinner turns out to be but a vaunted hope of replenished vigour. The blood in these cases I have found from pathological reports to be practically that of chronic anæmia with little power or tendency to coagulate. I will not trouble you with these reports, but you may take it as correct that they all suffer from a great deficiency of globular elements, and particularly the white, with a deterioration as far as can be judged by the hæmometer of the red.

Now, given such cases, it will be found that one of the most potent remedies in the hands of the surgeon is that of "direct transfusion of blood." It is astonishing the quick improvement that takes place with a well-done transfusion, as will be seen in the patient being quickly able to get up, which in itself is a means often of overcoming the pathological condition. I do not, of course, say it is often the means of bringing about, though temporarily, a healthier quality which enables the surgeon to proceed to further treatment.

Take, for instance, the case of frost bite, which had also suffered from chronic dysentery, who lay for months without showing any signs of discarding or defining properly the delineation of the gangrenous parts, with chronic symptoms of debility and exhaustion, blood vitiated with toxins, a once vigorous constitution tottering to its doom. Or I take the case of a long and serious operation, where a great, and likely a necessary but exhausting hæmorrhage has taken place which takes long periods to (if ever) recover from. Given such cases as have occurred with me, and the surgeon will see the great benefit of a direct transfusion of blood, taking ten to twelve ounces from a plethoric or healthy or other soldier properly selected. The results will speak for themselves: wounds heal, cardiac impulses improve, better quality of blood, better digestion, etc., etc., all these become immediately evident.

For brevity let me observe the following points I have practised in direct transfusion of blood.

Choice of Cases.—These have been almost entirely confined to my surgical cases where there has been no idiopathic disease or dyscrasia present. I have not done "transfusion" in any patient who was still losing blood.

Choice of Donor.—If possible, take a near relative, preferably a healthy

brother or sister, due attention being paid to past history. If impracticable, and you have to go abroad relatively, the utmost scrutiny must be exercised as to the probability of infection. The donor in average health can give ten ounces of blood without the least danger. The quantity can be easily estimated during the flow.

Dangers to the Donor.—These are few. If the donor is between 20 and 30 years of age, and healthy, ten ounces of blood can be withdrawn before the first symptom appears of hæmorrhage, namely, a deep sigh. When this appears, it is an indication that the heart is finding difficulty in getting volume to contract on, and it is not a dangerous symptom, as experience will show.

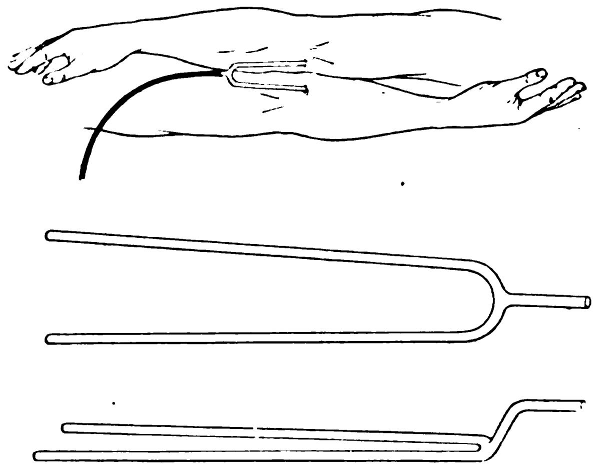
The prime danger to the donor is faulty technique, which I shall refer to later. If the surgeon commands the respect and confidence of the donor, and explains that all the blood required of him will not affect his health, that the operation he can sit and see himself, that it requires no chloroform, he will be quite docile, and be no trouble, and will readily assent. I have drawn one and a half pints at one séance without a sigh from the donor.

Dangers to Patient.—These are usually referred to as faulty manipulation infections through the blood. Injections of clots, injections of air, and *materies morbi*, dilatation of heart from large quantities or too rapid transfusion. To a careful and experienced surgeon these may be dismissed; even supposing a little air to be introduced, there is no danger. The author has frequently introduced small quantities of air without any untoward results. A small quantity of air is absorbed long before it reaches the cardiac cavities. Any one who has seen bad cases of gas gangrene and heard the gas being "churned" in the ventricles will readily acknowledge the harmlessness of the introduction of small quantities of air into the circulation. Regarding "premature clotting of blood or the introduction of clots," all I can say is, I have never seen it. If the surgeon uses the simple apparatus I have constructed, and carries out the instructions herewith given, there will not be the slightest coagulation of blood or the introduction of clots.

The *operation* is very simple. If the veins at the flexure of the elbows of the two parties are large and appropriate, the two right arms are chosen, sterilized, and placed side by side. If the patient is lying on an operation table or bed, the donor may sit by his side, and each right hand is in the other's axilla. By a tourniquet being applied in each arm, not tight enough to arrest the arterial flow, the veins stand out, and are easily exposed on their axes by the swift incision from a very sharp scalpel. It is not necessary to divide the vein. By a little patience the glass tube or transfuser can be inserted into the lumen of the vein through a longitudinal incision, and each lip caught by dissecting forceps, thus avoiding the necessity of stitching the vein later. The tourniquet

should not be removed from the donor's arm during the transfusion, but, of course, must be from the patient's.

The transfuser I use in "direct transfusion of blood" is made of a glass tube bent at an open curve of three millimetres bore. Through this tube I have found blood travel when conducted as above at the rate of nine to ten ounces in thirty seconds. At the junction of the arms of the tube another glass tube joins it of the same calibre, to which an india-rubber tube is attached through which warm saline can at any moment be allowed to flow from a vessel held and controlled by an assistant.



This will be found of great interest, for at the operator's will, during the transfusion, which will demonstrate the remarkable speed at which the blood is flowing, I always insert the transfuser full of warm saline, and stop its flow the moment the blood enters the tube. This prevents the risk of coagulation taking place in the tube before entering the vein.

With the donor's pulse and respiration in the hands of an experienced person, the blood is allowed to flow for twenty to thirty seconds, then the transfuser is withdrawn, the tourniquet taken off the donor's arm, and both arms elevated; little or no blood will flow from the wound, and a couple of stitches to each wound, with a sterile pad and bandage, completes the procedure.

If the veins of the arm are not in one of the individuals suitable, it may be necessary to find a good substitute in the long saphenous or other distended vein of the leg.

The transfuser I refer to is easily made, and costs but a trifle. It can be at once sterilized, and kept so for any length of time.

One or two attempts will transform the operation to one of the greatest simplicity, and demonstrate that the results will justify the author's opinion in the efficacy and value of direct transfusion of blood.

HEARING IN THE ARMY.

BY MAJOR JAMES KERR LOVE.
Royal Army Medical Corps.

ANY medical man who has been in charge of ear cases in a military hospital during the present War will have come to these two conclusions :—

(1) Most of the cases of deafness amongst those invalided home are due to middle ear suppuration.

(2) That middle ear suppuration has in most of the cases existed before the War began—indeed for years before the enlistment of the soldier.

It is too soon to collate statistics on the ear affections of recruits and of soldiers, and medical men are too busy with the actual work of the War either to write or to read papers including these statistics ; but as the War does not seem to be nearly over and as the recruiting which is still to be done will in most cases involve serious interference with home life, it may be well to inquire into the examination of the ears, and the test for hearing, which are applied to recruits at the present time.

It is to be feared that great slackness has existed in this examination and in applying these tests. Often no examination was made and no test was applied. As a consequence many keen young volunteers were sent to the Front only to be sent back from distant parts for prolonged treatment in hospital and for discharge from the Army or at least from service abroad. When the cost of transport and of the treatment of these soldiers is reckoned up, it cannot be said that the examination of the ears and the testing of the hearing of these soldiers is unimportant work.

What are the tests for hearing for admission to the Army and to what extent are the ears examined? They are stated to be as follows :—

For the Army, "deafness is a cause of rejection if at all marked, i.e., if a candidate spoken to in an ordinary tone of voice answers without hesitation, nothing more will be required, but if he pokes out his head, puts his hand to his ear, or lets it appear he is deaf, then the examiner will be strict. N.B.—Each candidate has to sign a certificate *on honour* that he is not suffering from disease of any kind, so that if he may slip through first, he is liable to be caught if found unfit later."

Now there is a good deal of rough common sense displayed in the definition of the above test. Common sense on the part of the doctor and honour on the part of the recruit are excellent things to begin with, but they do not go very far in the making of a scientific examination or in the application of a scientific test. A man may be quite deaf in one ear, and yet he may in a recruiting room answer without hesitation when spoken to in an ordinary tone of voice, and a recruit may be very deaf in one ear and may have discharge in one or both ears and may know nothing about either the deafness or the discharge. Further, many a man does not think a little discharge from the ear is a disease at all.

If recruiting is to be profitable and not wasteful, if fighting is to be effective and not disappointing, the ears of the recruit must be actually examined and an easily applied test must be at hand. It would be well were this examination and this test always applied by a specialist, for I cannot assume that most general practitioners are able easily and quickly to detect a perforation in the tympanic membrane or a little discharge lying in the middle ear.

The object of the writer of this paper is to make the detection of suppuration and of deafness so easy that any medical examiner may conduct the examination of the ears of recruits. One good point about the present Army test is that it has speech for its basis. As a test for acuity of hearing, speech is far the most important. Watches and acoumeters are useful, but as the purpose to which hearing is put both in military and civil life is for the most part to make out what another fellow creature is saying, speech must always be the most important test for hearing. It is true that other uses are found for hearing. In the Army, men are put to listening posts, where sounds differing from speech both in pitch and quality have to be appreciated. One soldier alleged to the writer that when at a listening post he was blamed for being asleep by an officer whose voice he did not hear, and that as a punishment he was put for twenty-eight days to the wheel. I found him to be very deaf, and that his deafness was due to disease of old standing. Whether this man was asleep on duty does not come within the scope of my inquiry, but he was far too deaf to be of any use at a listening post. Speech then is to be the standard test for the recruit, and could a standard of conversational speech be found, it would be a perfect test. It has not been found possible to give a standard even for male voices. These vary so much in pitch, quality and intensity that no uniformity in use gives a constant result which could be used as a test. But when speech is whispered *from the almost deflated chest*, a sound of almost constant character is emitted. Such speech in a quiet room should be heard by a good ear at about twenty yards. Now we are not discussing perfect hearing, which seldom exists in both ears. We are seeking for a minimum of hearing with which a soldier may discharge his duties, quickly and without error. In civil life the writer has formulated the Six Feet Rule, which he finds of practical value in his work as a consultant and as a school aurist. It is as follows :—

If an adult does not hear whispered speech with one ear at a distance of at least six feet, he cannot conduct business without difficulty, but will have recourse to lip-reading or to some aid to hearing. In school-life, if a child does not hear whispered speech with at least one ear at a distance of six feet, he should not continue in the large classes of an ordinary elementary school. This standard is not good enough for the Army. The whispered speech hearing of a recruit should be better than this, and both ears should come up to the standard. But a twelve-feet hearing

of whispered speech in both ears would give efficiency for practically all duties, and this is the standard the writer would recommend for recruiting during the present War. It is possible that the duties at a listening post may require better hearing than this, but it is probable that this is good enough for sentry duty. In both of these positions very acute hearing must be an advantage. In both, hearing below the twelve-feet standard must always be a disadvantage and sometimes a danger.

It need only be added that in applying this test the ears should be tested separately and that, to prevent lip-reading, the recruit should be so placed as not to see the lips of the examiner. Tuning-forks need not be used in the testing of the hearing of recruits. It is the fact of deafness, not the location of the cause of deafness, which is to be discovered. Detection, not treatment, is the object of the recruiting officer. No doubt temporary causes, such as a ceruminous plug or a cold in the head, may explain the deafness of the recruit. In that case the examiner may refer the recruit for treatment and have him re-examined at a later date.

Every recruit should be asked whether he has or has ever had a discharge from the ear, but in addition an otoscopic examination should be made. In this way ceruminous collections would be detected, and if a fine cotton-tipped probe be passed through the speculum under a good light, a layer of pus simulating a tympanic membrane will always be detected. No recruit should be sent on foreign service with a discharging ear, even when hearing is not greatly impaired.

Before concluding, I would make an appeal in the interest of the soldier. Let every officer speak distinctly. If he must speak loudly, let him also speak distinctly. Whether he speak loudly or not, let him always speak distinctly. Above everything, let his men see his face. Speech is nearly always read as well as heard. If a given standard of hearing be necessary for the recruit, a standard of distinctness in speech is due the soldier. Both officers and soldiers are "neither children nor gods, but men in a world of men."

THREE CASES OF GUNSHOT WOUNDS OF SKULL, TREPHINING AND RECOVERY.

By Captain H. V. DREW.
Royal Army Medical Corps.

Case 1.—Patient's scalp had been little more than grazed by a bullet. On admission he had no symptoms except complete paralysis of the left external rectus. Pulse and temperature normal, no sickness, optic neuritis, or headache. A few days later he seemed to be getting a trifle duller, so I decided to trephine him. Two small trephinic holes were made parallel to the longitudinal sinus on the left side, and the intervening bone removed by cutting forceps. He had *no external fracture*, but

the inner table was broken up, all particles and about an ounce of pus was removed, the cavity flushed out with saline, and a tube inserted. After the operation he developed paralysis of the *right* external rectus, as well as the left; later the right recovered completely, then the left; the wound gradually healed, and he recovered without any sign being left of his injury except the scar.

Case 2.—Patient had a depressed compound fracture over the right motor area, with complete hemiplegia of the left side. I trephined him, removed all the bone and debris; he recovered and the wound healed; but a good deal of his paralysis would probably be permanent, although he had made a certain amount of recovery two months after.

Case 3.—This man had been hit by a bullet which passed through his frontal lobes from right to left, badly fracturing his frontal bone, and causing a large cavity at the place of exit. A flap was turned down from the forehead and all the broken bone, etc., removed; tubes were put in on either side and the flap sutured in position. This patient recovered perfectly, but gave a lot of trouble as he would not be touched without an anæsthetic. These were the only cases of fracture of the skull that passed through my hands at *Netley* and, if it is permissible to draw any deductions from such a small number, I should say that success was due partly to perfect drainage, but chiefly to taking care *not to disturb the parts beyond the injured area*, which was shut off from the general cranial cavity, as the cases did not reach me for at least a week after the injury.

A NOTE ON THE CAUSATION OF TRENCH FOOT.

By C. NEPEAN LONGRIDGE, M.D.Vict., F.R.C.S.Eng., M.R.C.P.Lond.

Having had the opportunity of looking after some number of men suffering from trench foot of varying degrees of severity, I have been impressed by certain characteristics which this condition presents.

A considerable degree of anæsthesia is often found for one thing, but a more remarkable feature to my mind is an apparent loss of vitality in the tissues affected. The slowness of the healing process, the feebleness of the scar tissue produced and its readiness to break down at the least provocation, are points which remind one of the trophic sores which are found in various nervous diseases.

It is now becoming recognized that electrical currents can be detected in all healthy tissues by the aid of a sufficiently sensitive galvanometer. When the nerve supply to a part is cut no current can be detected, a fact from which it is reasonable to draw the deduction that the current is carried by the nerves. It is stimulating to imagine that this current is actually what we have hitherto talked about in a somewhat vague fashion as "the trophic influence of the nerves." In a case of division of the

median nerve in the forearm I found no deflection from my galvanometer (which is an extremely sensitive one of the Kelvin type), from the fingers which are anatomically known to be supplied by that nerve, and I obtained similar results from a case of division of the ulnar nerve. Recent researches on the ionization of cells add weight to the idea that the trophic influence of nerves is probably something which is indistinguishable from electricity.

The following experiments were carried out:—

Experiment 1.—One pole of the galvanometer was connected by an insulated cable to a copper plate embedded in the earth, the other pole being connected to a suitable electrode which was grasped in the hand. A brass tube one inch in diameter was connected by another cable to the main water supply of the house, thus making a good earth connexion. It is essential before testing, for the subject of the experiment to hold on to the brass tube with the bare hands in order to earth him and so allow any induced charge of which he may be the host to run away to earth. If after earthing he holds the brass tube in one hand and the electrode connected to the galvanometer in the other a brisk off-scale deflection is produced, this shows: (1) that the galvanometer is working properly; (2) that the subject is giving out a current which is independent of any induced charge he may have picked up; and (3) that the earth wires are efficiently connected, since obviously the circuit must be completed through the earth.

Experiment 2.—The brass tube was laid on the floor which was covered by a fairly thick carpet. One hand held the electrode as before, the other being free. The feet in an ordinary pair of boots of which the soles were perfectly dry were then placed on the brass tube. No deflection was obtained, showing that with dry boots on no connexion was made with the earth.

Experiment 3.—Was of a precisely similar nature with the exception that the soles of the boots were wet. In this experiment a rapid off-scale deflection was obtained, showing that with wet boots a good connexion is made.

Experiment 4.—Both poles of the galvanometer were connected to electrodes held in the hands, the earth plate being disconnected. The brass tube still remaining connected to earth as before was placed on the floor. When the galvanometer circuit was closed a deflection was produced and the spot of light became steady at 170 millimetres on the negative side of the scale. The feet in wet boots were then placed on the brass tube and very slowly the spot began to move towards zero but became stationary at sixty millimetres. On removing the feet from the tube the spot slowly moved up again to 150 millimetres where it became stationary. This experiment has been repeated several times with similar results, with the exception that sometimes the spot has

moved past zero and become steady about forty to sixty millimetres on the positive side of the scale, which is a fact I cannot well account for.

I am aware that it is dangerous to draw conclusions from experiments such as these, but one deduction can safely be drawn, viz., that leather when dry is a bad conductor, when wet a good conductor. That is, of course, no news. With the aid of Miss Flecker at the Ladies' College Physical Laboratory, I attempted to measure the resistance of a piece of oak-tanned sole leather three inches long by one inch wide and we found it practically infinity, whereas when wet its resistance is that of the fluid in which it is soaked.

The last experiment seems to indicate that when a man stands on wet earth in wet boots for any length of time a gradual drainage of electricity takes place from his body. In the light of these experiments the motherly advice not to stand about in wet boots takes on a scientific aspect which should claim our belated respect.

It seems to me possible that trench foot is a trophic affair produced by the local loss of electricity or "trophic influence" from the nerves of the feet, and the prevention of it is obviously to interpose a dielectric between the feet and the earth. Professor Leonard Hill's recommendation of rubber boots and thorough greasing of the feet is one that I should absolutely concur in though for different reasons to those he adduced.

Reviews.

A Short Course on First Aid in Accidents. By Lieutenant-Colonel Sir John Collie, M.D., and Major C. F. Wightman, F.R.C.S.Eng. London: George Gill and Sons, Ltd., 13, Warwick Lane. Pp. 48.

Perhaps first-aid was not as popular as it might have been before 1914. The bloody realities of the present titantic conflict have brought many facts home to the public, especially the need of a knowledge of first-aid. The story has of course been told before. It certainly is most simply and clearly expressed in this little work, and for that reason we can strongly recommend it to instructors in first-aid as an ideal work for their students. Unnecessary facts are left out, but all theory and practice needed is given, and what is more in such a way that, coupled with practical work, it should easily be assimilated and remembered.

A Compendium of Aids to First-Aid (First-Aid Simplified and Tabulated). By N. Corbet Fletcher, M.B., M.R.C.S. London: John Bale, Sons and Danielsson, Ltd. 1916. Pp. 67. Price 6d. Third Edition.

Some of the profession may have pleasant remembrances of "Tips and Phrases" that in their student days helped them to recollect anatomical and other professional matters. These may perhaps recom-

mend this little work to their first-aid pupils. Only it is to be hoped, that if they do so, they will also insist, as the author does, on an ordinary text-book being studied, as well as the importance of plenty of practical work.

Coupled with this, this compendium may serve to concentrate that knowledge in a form that may readily be turned to account either for practical application in times of accident or in ambulance competitions.

THE TREATMENT OF DISEASES OF THE SKIN. By W. Knowsley Sibley, M.A., M.D., B.C.Camb., M.R.C.P.Lond., M.R.C.S.Eng. London: Edward Arnold. 1916. Pp. xii and 307. Price 6s. net.

The volume under review is a convenient sized handbook of 304 pages, illustrated by sixteen plates.

It gives briefly and clearly the latest scientific methods of treatment, such as carbon dioxide snow, X-rays, radium, electrolysis, kataphoresis, galvanism, and high frequency, sinusoidal and faradic currents.

It is thoroughly up to date and should certainly be of great use to dermatologists and practitioners of medicine.

THE STORY OF A RED CROSS UNIT IN SERBIA. By James Berry, B.S., F.R.C.S., and others. London: J. and A. Churchill. 1916. Pp. xvi and 293. Price 6s. net.

This is the story of a gallant adventure such as there have been and may yet be many in the course of the present War. The Serbians, after their early repulse of the Austrians, were sore beset. Their country had been in part devastated, supplies of all kinds were lacking, and then typhus broke out. It was in these circumstances that appeal was made to Britain, and this mission was one of many that came into being in answer to the call. Mr. and Mrs. Berry had enjoyed a brief holiday in the country, and their efforts to raise, and success in bringing help arose, not only from their interest in a kindly race whose hospitality they had enjoyed, but also from the feeling, less expressed than implied, that Britain owed Serbia a great deal more than had—officially, at all events—been paid. Whatever the motive, in a few weeks the money had been raised, the staff chosen, and the hospital equipped, and this book is the tale of its faring. Before it is told, it has to record the third and successful invasion by the enemy of this afflicted country, and the authors themselves had, perforce, to taste for a short period the discomforts of captivity which, indeed, were little more than those arising from the fear that they would be detained as prisoners, in defiance of the Geneva Convention. That such, happily, was not the case this book is public evidence. It is a joint production and whatever other advantages such a form of authorship may have, it does not lend itself to a sustaining of the narrative, nor to unity of style. The general effect is thus something disconnected. But, after all, these are small blemishes. The solid fact that remains in the mind when closing the volume is one, not of criticism of the form of the story, but of profound respect for these men and women who—in the majority of cases, without fee or reward, though, to speak justly, no undue weight is laid on the circumstance—went forth to a life of toil and far from improbable danger to bring such relief as they might to a grievously stricken people.

A short and lucid account is given of the incidents which were made the pretext for War, and the rest of the book is taken up with the record of the setting up of the hospital, the difficulties encountered, and how they were met. An interesting chapter gives some information of the Serbian people, their manners and customs and the story of "the flight of the three" members of the staff, who elected to adopt this method of escape than to trust to the tender mercies of the enemy, loses some of its horror by the cheeriness of its telling. That typhus can be—as it was—treated in a general ward after rigid precautions have been taken to remove lice from the clothes and person is, we believe, the chief observation of outstanding importance. Lice were known, of course, to be carriers of the disease, but to convert the theorem "no lice, no typhus" into an axiom is no inconsiderable step forward.

For the rest, it would almost seem that the authors had set before themselves the ideal to be fair and charitable though the heavens fall, for we can recall but very few instances where they have been betrayed into harshness of comment—even the enemy have their meed of praise—though it is not hard to see that often was their patience tried. To the cynical, indeed, the obviously earnest and entirely praiseworthy endeavour to give their due share of credit to the several members of the staff savours somewhat of the proceedings of a Mutual Admiration Society, a fault, if fault it be, so rare that it may pass for virtue, and one not unworthy of more general emulation. It will not get it, however.

There are some photographs which would have been better had they been larger. We would have been glad to exchange them for an index.

H. R.

First-Aid for the Trenches. By Captain Somerville Hastings, R.A.M.C (T.F.), M.S.Lond., F.R.C.S.Eng.. London: J. Murray. 1916. Pp. xiv and 49. Price 1s. net.

Although these are days of more or less stationary warfare, when a man, wounded in the front line of trenches, may receive the immediate attention of a stretcher-bearer in an adjacent dug-out, or often, not many minutes later, the professional care of a regimental medical officer, there are moments when a soldier, left to his own resources with a wounded comrade out on a bewildering battlefield of stricken men, may have cause to regret his ignorance of First-Aid. He has learnt how to apply his phial of iodine and his first field dressing, and he has mastered the art of affixing a tourniquet without ever searching for more than a disciplinary reason. And so if he is acquiring many handbooks and absorbing useful hints to meet the exigencies of trench life, his stock of information will not be complete without Captain Hastings' short treatise on a few vital facts of emergency surgery.

This handbook is attractively illustrated and, if at times rather technical for the man in the ranks—giving the "little knowledge" which might be dangerous—it is very clearly written, concise, and surprisingly complete.

The subjects of wounds, fractures, states of unconsciousness, suffocation, burns, and the transport of the wounded are successively dealt with, and, in conclusion, there is a rather shortened summary of trench hygiene. The very special bacterial flora of the septic wounds of France, the need

of cleanliness, and the necessity of covering wounds quickly, are driven home to the soldier reader simply and tersely. Perhaps the most useful chapter is that which explains, with photographs, the many methods of carrying a wounded man. In the remarks on fractures no mention is made of improvising pads for splints. Surely a man with a compound fracture of the femur, whose leg has been immobilized in the fire-trench with a rifle, which will certainly remain in position at his side until he reaches the nearest dressing station of a field ambulance, would be the better for a padding of clothing (tunic or overcoat) or grass, straw or leaves bound on to the splint with puttees or bandages. This seemed to us rather an essential detail in a handbook of details.

To officers and non-commissioned officers, to the platoon commander and his serjeant, these bulwarks of the battalion, "First-Aid for the Trenches," will be a boon.

Current Literature.

Flies and their Relation to Epidemic Diarrhœa and Dysentery in Poona. (By Captain J. Morison, M.B., D.P.H., I.M.S., and Captain W. D. Keyworth, M.B., I.M.S. *The Indian Journal of Medical Research*, April, 1916, vol. iii, No. 4.)—In a previous paper [1] of which this is a continuation, the relation between the large number of flies in Poona during the rainy season, and the annual epidemic of diarrhœa and dysentery which appears at that time was considered.

Previous to the publication of that report, it was held by many that flies were the cause of that epidemic. Indeed, largely owing to the suggestive paper by Captain Ainsworth published in 1909, [2] Poona had obtained a place in the literature of flies and disease, and is referred to in books on this subject as a place where the causal relation of flies to enteric fever, intestinal disease, and infant mortality may be assumed. During 1912 and 1913 the relation of flies to epidemic diarrhœa and dysentery was studied by one of us more thoroughly than had previously been possible, and it was evident that while both flies and intestinal diseases were numerous during the monsoon, the seasonal prevalence of flies did not have that relation to intestinal diseases that was demanded if flies were to be accepted as the principal cause. It was shown in the report referred to that the complete explanation of the annual epidemic was to be found not in its relation to flies, but in its relation to pollution of water supply.

Taking the flies caught at Yerowda Jail during 1914, and placing the numbers beside the figures for diarrhœa and dysentery at the Jail (Chart I), it will be seen that for the third year in succession the flies and the number of cases increased side by side, and that in this year the increase in flies preceded by a week the increase in the cases.

Indeed, between June 10 and August 12, the correlation between flies and disease is obviously high.

TABLE I.

FLIES CAUGHT EACH WEEK AT FIVE STATIONS, POONA, 1914.

Weeks	Detention Barracks, Wanowri; 10 fly papers	No. 13 Right Flank Lines; 4 fly papers	No. 8, Queens Gardens; 6 fly papers	29th Cavalry, Ghorbari Lines; 12 fly papers	Yerowda Jail; 20 fly papers	Total of each week	Average per fly paper
June							
7 to 13	—	228	158	21,787	8,083	30,256	720·4
14 ,, 20	—	406	331	33 748	21,635	56.120	1,336·2
21 ,, 27	1,104	1,741	3,806	70,746	50,438	127,835	2,458·4
July							
28 to 4	13,934	5,356	13.095	99,119	107.457	238.961	4.595·4
5 ,, 11	18,383	7,838	11,915	—	83.806	121,942	3,048 5
12 ,, 18	16,970	7,174	11,783	87.568	91,360	214,855	4,131·8
19 ,, 25	15,250	6,987	10,576	87,562	86,855	207,230	3,985·2
26 ,, 1	5,181	3,507	3,252	81,995	86,588	180,523	3,471 6
August							
2 to 8	—	1,892	1,866	45,758	19,588	68,304	1,626·2
9 ,, 15	431	418	206	12,771	4,086	17,912	344·5
16 ,, 22	1,128	409	201	6,307	3,368	11,413	219·5
23 ,, 29	1,180	289	311	14,930	4,826	21,536	414·2
September							
30 to 5	1,573	372	636	12,048	3,637	18,266	351·3
6 ,, 12	1,722	354	541	—	5,154	7,771	194·3
13 ,, 19	1,262	212	161	—	—	1,635	81·7
20 ,, 26	700	—	193	—	—	893	55·8
Total ..	78,818	37,183	58,231	574,339	576,881	1,325,452	27,053·0

But as in 1912 and 1913, so in 1914 the correlation ends abruptly before the end of the epidemic has arrived. To the epidemic wave shown on August 19 there is no corresponding increase of flies. This wave, however, as will be shown in another paper to be published shortly, definitely connects the incidence of intestinal disease with accessions of pollution to the water supply, for it, and in a like manner the whole of the preceding epidemic, can be definitely related to the pollution brought to Poona by antecedent floods in the catchment area.

During 1915 fly counts were discontinued, but it was noted that the flies increased during the last fortnight of June, were very numerous in July, and decreased during the last fortnight of August. They seemed, and probably were, as numerous as usual. Their number was sufficient to reawaken the annual agitation for the mitigation of the nuisance, but the flies decreased before any definite campaign against them was begun. The evidence however of the previous three years, given in full in the above papers, was considered sufficient to warrant the careful supervision of the water.

Settling tanks had been brought into use on August 22, 1914.

From July 1, 1915, the supply was treated with bleaching powder.

From August 7, 1915, the cantonment supply was sterilized with hypochlorite of lime.

The effect on the city was an absence of the annual monsoon mortality from intestinal diseases and an absence of the large annual monsoon increase in the death-rate among children.

In the British regiments where the epidemic began in its usual way, the treatment of the water was at once followed by a reduction of the disease to its dry-weather level; indeed, the removal of the monsoon

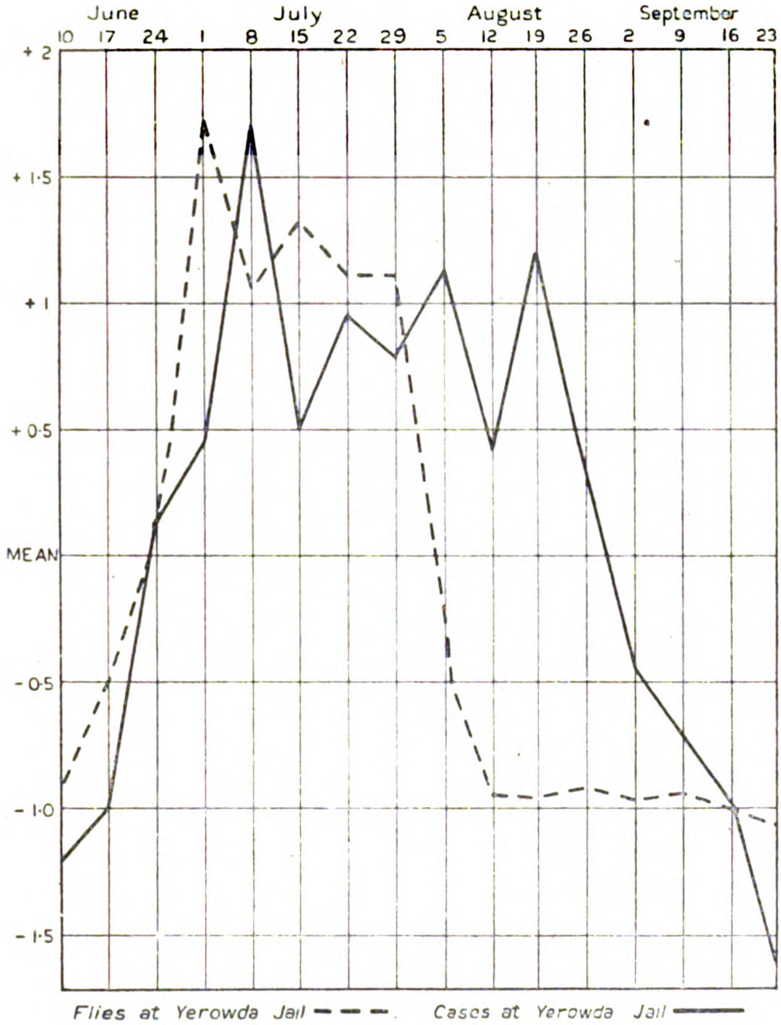


CHART I.

epidemic was so complete that it was difficult to see how flies could have anything to do with the annual epidemic of gastro-intestinal disease or with the increase in the adult and in the infant mortality from this cause.

The evidence against flies being a causal factor in epidemic diarrhœa

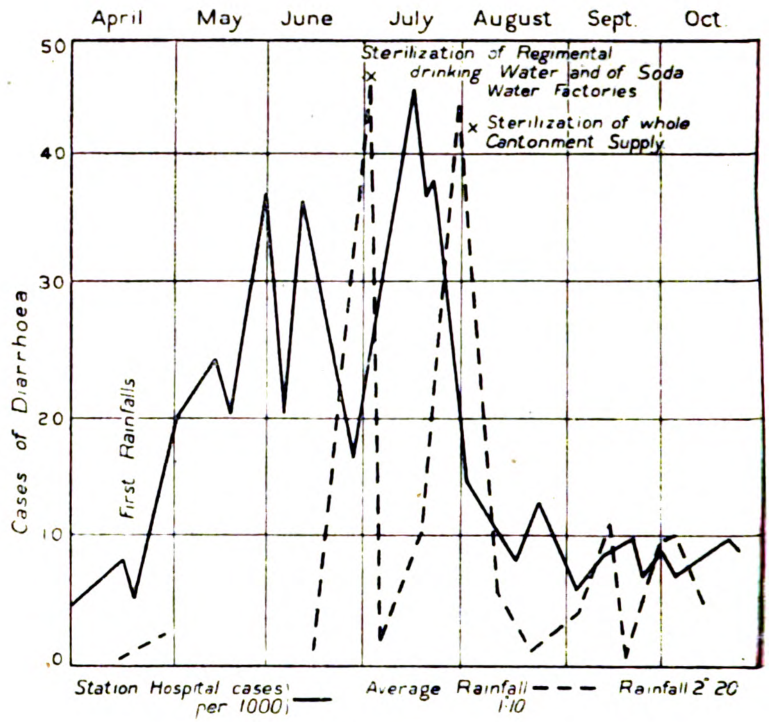


CHART II.

Station Hospital cases and rainfall in the catchment area each week, 1915.

TABLE III.

DEATHS FROM DIARRHŒA, DYSENTERY AND CHOLERA.

Year	April	May	June	July	August	September	October
1912	142	137	147	399	307	177	112
1913	106	107	92	162	128	118	40
1914	135	111	72	281	160*	77	41
1915	51	50	57	35†	68	84	67

Deaths among Children from 1 to 5 years.

Year	April	May	June	July	August	September	October
1912	86	87	117	226	248	163	166
1913	152	141	62	118	103	103	53
1914	94	91	60	144	161*	73	63
1915	60	59	79	65†	90	77	59

* Settling tanks brought into use on August 22.
† Treatment of water with bleaching powder began July 1.

and dysentery was not less strong in the crowded insanitary and fly-plagued city than it was in the well-appointed military cantonment. The treatment of the water has been adopted as a permanent measure.

SUMMARY.

The general prevalence of flies in Poona can be estimated at any station where the local conditions are maintained the same from day to day.

During 1914, as in the two preceding years, the correlation between flies and gastro-intestinal disease was very close during the earlier part of the monsoon; but the relation between flies and disease, as in previous years, ended abruptly before the conclusion of the epidemic.

The last portions of each of the three annual epidemics cannot be ascribed to flies.

During 1915 treatment of the water supply with hypochlorite of lime was undertaken. Flies during this year were as great a nuisance as usual, but the effect of the treatment of the water on the annual epidemic was so great that in the city during the usual epidemic months of July and August there was no increase of the deaths from gastro-intestinal disease, and no increase in the child mortality. In the cantonments where the annual epidemic had already shown itself treatment of the water was followed at once by a complete disappearance of the epidemic.

The evidence indicates that flies in spite of their number do not contribute appreciablv, if at all, to the mortality in the city of Poona, or to the annual epidemic of gastro-intestinal disease in Poona cantonments.

REFERENCES.

[1] MORISON, J. "The Causes of Monsoon Diarrhœa and Dysentery in Poona," *Indian Journal of Medical Research*, vol. ii, No. 4, April, 1915.

[2] AINSWORTH, R. B. "The House-fly as a Disease Carrier," JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, May, 1909.

Correspondence.

BATHS FOR SOLDIERS IN THE FIELD.

TO THE EDITOR OF THE "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."

SIR,—In the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, of September, 1916, there was an interesting article about "Baths for Soldiers in the Field" (p. 363), by Captain Goode, R.A.M.C.

I was especially interested to read his account of what is done now in France, as I had the good fortune to organize the first baths and laundry that were ever started there while with the 4th Division, and had to make new arrangements for baths and laundry at each move.

I should like to congratulate him and Captain Hughes on solving the difficulty of purifying the water and using it over again, the only drawback of it being, as far as I can see, that it requires a permanent set of tanks, etc., which is not easy to get built if one does not know how long the division will remain in the same area.

I should like to ask Captain Goode, R.A.M.C., for the following details (reference block plan, p. 365) :—

(1) What are the tram lines used for?

(2) What are the sheds, three drying and one washing, used for? (as I understand washing and drying is done elsewhere).

I am glad to see that apparently the type of boilers and sprays first used by the 4th Division for baths are still employed (reference ground plan, p. 366).

(3) In the case of sprays for officers, is there another boiler and spray which is not shown in the plan? If not, what is used? I notice tunics are not disinfected.

(4) Who does the ironing, and how many are required to do the same?

(5) How long does a bottle of formalin last when poured into a Thresh disinfector?

(6) What staff is required to run the baths, and how is the lighting carried out?

(7) What is the expense per month of running the laundry, and what is paid per article washed?

(8) Is a Foden Thresh or the old Thresh employed, and how are all the underclothes disinfected each day as well as the men's trousers?

I am, etc.,
J. B. GROGAN,
Captain, R.A.M.C.

October 21, 1916.

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Original Communications.

OBSERVATIONS ON THE SERUM REACTION OF THREE HUNDRED UNSELECTED CASES OF "ENTERIC"[1] FROM THE EASTERN MEDITERRANEAN, WITH THE OXFORD STANDARD AGGLUTINABLE CULTURES.

By Captain ERNEST GLYNN, F.R.C.P.,
Royal Army Medical Corps (T.), Pathologist, First Western General Hospital,

AND

E. CRONIN LOWE, M.B., B.S.,
Pathologist, St. John's Hospital, Southport, from the Pathological Laboratory, University of Liverpool.

During the last few months a large number of "convalescents" from the Eastern Mediterranean have entered the Auxiliary Hospitals of the First Western Command with a diagnosis of typhoid or enteric, and some with a diagnosis of paratyphoid.

As nearly all have been recently inoculated against typhoid, though not against paratyphoid, it seemed to us highly probable that many of the cases were wrongly diagnosed as typhoid, especially as a large number had certainly suffered from dysentery.

Because practically all were "convalescent," nothing could be learned by blood cultures, and very little by examining the excreta;

[1] "Enteric Fever: Varieties: (*a*) Typhoid fever; (*b*) Paratyphoid fever." See 1916 edition "Nomenclature and Classification of Diseases." Roy. Col. Physicians. At present in the press. *Lancet*, 1916, vol. i, p. 887.

we attempted to arrive at a bacteriological and therefore correct diagnosis by testing the agglutination reactions with the Oxford Standard Agglutinable cultures of typhoid, paratyphoid A and B.

The work was commenced in the second week of November. Three hundred unselected cases were examined, drawn as far as possible consecutively from St. John's Hospital, Southport, Liverpool Royal Infirmary, the Liverpool Tropical School Auxiliary Military Hospital and Mill Road Auxiliary Military Hospital. Most of the work was done in the Pathological Laboratory of the University of Liverpool, the rest in Southport.

Agglutination Technique.

The technique was carried out exactly as recommended in the "directions" issued from the Department of Pathology, Oxford University, on behalf of the Medical Research Committee [19]. In order to save time many pipettes were used, and the drying of the pipettes and agglutination tubes after washing was hastened by placing them in a hot oven.

The agglutination tubes were incubated in a water bath at 55° C., and kept at that temperature by placing the bath in a paraffin oven supplied by Baird and Tatlock; the oven accommodated eight racks of tubes.

After two hours' incubation the tubes stood for ten to fifteen minutes at room temperature, and then the readings were taken. This was done in a cupboard with a black background containing an electric lamp; the cupboard prevented daylight of varying intensity diffusing into the electric light, and so causing the readings taken during the day or night to differ. Some such apparatus as this is essential for accurate work, especially if the readings are taken by different observers.

The readings were all taken by one or other of the writers, but the technique in fully a third of the cases was carried out by a laboratory assistant who was quickly taught. Every serum was tested to typhoid, paratyphoid A and paratyphoid B, the dilutions being 1 in 25, 50, 125, 250, also, if necessary, 1 in 500, 1,000, 2,500, 5,000. Frequently there was an agglutination with *sedimentation* in a tube, e.g., 250, and no agglutination whatever in the next, e.g., 500. In such cases the agglutination titre is indicated in our paper by 250+.

Agglutinin Units.

In order to ascertain the number of "Standard Agglutinin Units" it is necessary to divide the titre by a figure given on the bottle.

During our work this denominator for paratyphoid A varied from 2·7 to 4·1, and for paratyphoid B from 2·7 to 3·5, a change which had no appreciable effect on our results. The figure for typhoid, however, gradually rose from 4·7 to 7·7; in certain cases this change raised the agglutination titre, e.g., Case 9, paratyphoid A series, first examined seven weeks after convalescence, titre 125 (denominator 5·6); three subsequent examinations, titre 250 (denominator 7·7). If such an alteration in the emulsion has undoubtedly caused an apparent rise in titre we have assumed, when interpreting our results, that there has been no change in titre.

We have found the Oxford emulsions most satisfactory. On rare occasions they become cloudy after frequent use, probably from bacterial contamination.

Collection of Blood.

Our greatest practical difficulty was to obtain sufficient blood to yield a necessary six complete drops of serum. We found it necessary to direct special attention to the following points:—

(*a*) *Wright's Capsules.*—Those supplied by many firms are too small and not properly shaped. The lumen of the tube should be at least $\frac{3}{8}$ inch in diameter, the length, excluding the tapering ends, $1\frac{1}{2}$ inches. The curved end should be of wide diameter and short, otherwise the large drops of blood will not flow quickly into the tube, and fall on the floor.

(*b*) *Collecting the Blood.*—The patient was instructed to hang his arm down, or better, to swing it round several times. If necessary he soaked the hand in hot water to cause vascular dilatation. A rubber catheter, not a piece of tape, was bound round the finger as far as the terminal phalanx, and the back of the finger pricked near the nail with a *large triangular surgical needle*, size No. 1; an ordinary needle does not make a large enough hole. If enough blood was not obtained the rubber was removed, and after the finger had been massaged it was reapplied; 0·75 of a cubic centimetre of blood is sufficient. The blood was collected by the ward sisters, who became experts after a little tuition.

Accuracy of Technique.

Hort [10] states that, although employing Dreyer's emulsions, "we do not find the drop method of sufficient accuracy for routine work on a large scale."

After making over 3,000 examinations we disagree with this statement, for example:—

(*a*) Sixty-six consecutive convalescent cases of "enteric" had their typhoid agglutinins estimated on four occasions at intervals of about a week; about eighty per cent of the tests were done by one observer.

In 34 convalescents all 4 *tests* gave the same titre; including 5 convalescents, in which the titre rose one tube, due to a change in the emulsion denominator, from 5·6 to 7·7.

In 15 convalescents 3 *tests* gave the same titre, the variation in the remaining test was a rise or fall of one tube only; in 10 cases this variation was probably due to technical error, and in 5 cases to alterations in agglutinin titre.

In 15 convalescents 2 *tests* gave the same titre; 10 showed a variation in one tube only; 5 of which were probably due to error; the other 5 showed a variation of two tubes only, none of which were probably due to error.

In 2 convalescents *every test* gave a different titre, the extreme variation being three tubes, none of which were probably due to error.

(*b*) The results of repeated tests in the paratyphoid group of cases are given in Tables II and III. Though there is most probably one error in one of the tests in Cases 4, 5, 6, 7 and 12 (Table I, paratyphoid A series), and Case 3 (paratyphoid B series), yet the figures taken as a whole, and especially those showing the remarkable contrast between the behaviour of the paratyphoid "infection" agglutinins and the typhoid "inoculation" agglutinins, are additional evidence that Dreyer's method possesses a considerable degree of accuracy.

In our experience an alteration in titre of one tube only in successive tests with the same emulsion probably indicates an alteration in the amount of agglutinins, though it possibly indicates an error; whereas an alteration of two tubes certainly indicates an alteration of agglutinins—so long as gross carelessness can be excluded.

It is quite true that greater accuracy would be attained by using "considerable volumes" of serum as Hort suggests, instead of drops. This, however, is not practicable in most laboratories in war time, as it would require so much blood and more apparatus. It is quite true also that greater accuracy would be attained if the intervals between the tubes were less than 25, 50, 125, etc., for then the exact "end point" would always be reached, but this would again demand more time and apparatus.

Some of our errors were probably due to using slightly hæmolysed blood, for with it the "end point" is more difficult to read, to not

always obtaining six full-sized drops of serum, owing to insufficient blood being taken, and perhaps to keeping the blood on certain occasions three or four days before testing. It is probably advisable to hold the dropping pipette at the same angle when distributing the drops, and to use a separate pipette for each sample throughout the dilution technique.

In our opinion, the macroscopic method, as perfected by Dreyer and his collaborators, is eminently suitable for routine work on a large scale in war time, particularly for bacteriologists without any previous training.

The technique itself can easily be mastered by an intelligent orderly after a short time.

The method also has this great advantage, it is a successful and scientific attempt to standardize "enteric" agglutination tests, and therefore *make the results obtained in different laboratories strictly comparable.*

It is impossible to satisfactorily compare results obtained by using different macroscopic or microscopic techniques, and emulsions of different densities of sometimes dead and sometimes living organisms, derived from different strains, often of doubtful parentage, of different inherent agglutinative capacity, cultivated on different media, for different periods of time, often at different temperatures, and last, but not least, of using different standards for positive or negative results.

The average Briton, unfortunately, has a conscientious objection to employing standard methods and apparatus. It interferes with the "freedom of the individual."

The Medical Research Committee has, if we may be allowed to say so, acted most wisely, not only in advertising this particular "Standard Method," but also in supplying the apparatus and emulsions free to all Royal Army Medical Corps officers, and if it was generally adopted the ultimate gain would far outweigh any temporary loss.

Controls.

We have tested the diagnostic value of the standard emulsions by various controls, as far as our limited opportunities permitted, and have considered the following questions:—

(1) Does typhoid vaccine produce co-agglutinins for paratyphoid?

Test.—Twenty-five surgical patients from G—— inoculated with typhoid vaccine before July, 1915, who gave no history of typhoid or dysentery, failed to agglutinate paratyphoid A or B

in 1 in 25, even though four agglutinated typhoid in as high a titre as 250; one inoculated in January, 1915, did not agglutinate typhoid.

In numerous other observations not included in this paper we have found no evidence of co-agglutinins from typhoid vaccine.

(2) Do the emulsions demonstrate the presence of specific agglutinins in persons proved by culture to be infected with typhoid or paratyphoid?

Test.—Bacilli of the "enteric" group which were motile and gave typical carbohydrate reactions, and also typical serological reactions with the Oxford Standard Sera, have been isolated in the University Pathological Laboratory, from the excreta of fourteen convalescents, by Dr. Vera Foley, Dr. Mary Price and Dr. Robinson. They all gave positive agglutination tests with the Oxford emulsions.

TABLE I.

	Typhoid	Paratyphoid A	Paratyphoid B	
		Paratyphoid A Cases.		
B. T. ..	+ 1 – 50 ..	+ 1 – 250 ..	– 1 – 25 ..	—
A. L. ..	+ 1 – 125 ..	+ 1 – 125 ..	– 1 – 25 ..	—
F. M. ..	– 1 – 25 ..	+ 1 – 125 ..	– 1 – 25 ..	—
P. M. ..	+ 1 – 250 ..	+ 1 – 250 ..	– 1 – 25 ..	—
		Paratyphoid B Cases.		
P. T. ..	+ 1 – 1000 ..	– 1 – 25 ..	+ 1 – 250 ..	—
W. M. ..	+ 1 – 250+ ..	– 1 – 25 ..	+ 1 – 125 ..	—
R. M. ..	+ 1 – 1250 ..	– 1 – 25 ..	+ 1 – 250 ..	Chronic carrier.
G.	+ 1 – 1000+ ..	– 1 – 25 ..	+ 1 – 125 ..	—
S. A. H. ..	+ 1 – 125 ..	– 1 – 25 ..	+ 1 – 50+ ..	Chronic carrier.
J. S. ..	+ 1 – 50 ..	– 1 – 25 ..	+ 1 – 125 ..	Intermittent carrier.
W. S. ..	+ 1 – 250+ ..	– 1 – 25 ..	+ 1 – 25 ..	—
S. L. ..	+ 1 – 1000 ..	– 1 – 25 ..	+ 1 – 50 ..	—
		Typhoid Cases.		
S.	+ 1 – 50 ..	– 1 – 25 ..	– 1 – 25 ..	—
T.	+ 1 – 500 ..	– 1 – 25 ..	– 1 – 25 ..	—

There is no evidence of co-agglutination in these figures; the general question of co-agglutination will be alluded to later.

It will be noted that we have used the *Oxford* emulsion to test for the presence of agglutinins in cases infected with bacteria proved by the *Oxford* sera to be typhoid or paratyphoid. This is not altogether a strict test, for it is possible that the Oxford emulsions and sera work as it were "en rapport"; both for example might be prepared from the same strains of bacteria.

We therefore tested all our strains again with sera supplied by the Lister Institute, and they gave the same results as with the Oxford sera.

Paratyphoid-like bacilli, but failing to give typical carbohydrate or indol reactions or serological reactions with the Oxford or Lister sera, or lacking motility, have been isolated from many convalescents; but so far none of their sera have agglutinated the Oxford paratyphoid emulsions.

Dreyer [6] also found that every case proved bacteriologically to be infected with paratyphoid B gave a positive agglutination with the Oxford emulsions. On the other hand, in seven per cent of the paratyphoid A cases the patients' serum failed to agglutinate in a dilution of 1 in 25, "the limit below which he first thought no positive diagnosis should be made." However, he subsequently found that "an agglutination of 1 in 10 was for all practical purposes diagnostic in cases of paratyphoid A." Unfortunately we have only rarely tested our sera for paratyphoid A agglutinins in dilutions of 1 in 12.

Ledingham [12], using a different technique, says "a definite reaction even in 1 in 40 is to be regarded as significant in these A infections. Normal sera in our experience have given no reaction with paratyphoid A in this dilution."

(3) "Certain continental workers have recorded positive typhoid Widals in the early stage of bacillary dysentery. As the dysentry Widal became established the group reaction tended to disappear" (Ledingham [12]).

As thirty-one per cent of our cases stated that first diagnosis was dysentery, there is a possibility that such "group" agglutinins for typhoid or paratyphoid, if they were ever present in the acute stage of the disease, might have persisted after convalescence and so led to error.

Test.—The typhoid and paratyphoid serum reactions of sixty unselected cases of dysentery from the Near East were tested. All but some half dozen were convalescent. In two of these a bacillus giving cultural and serological reactions of *B. dysenteriæ* (Shiga) was isolated. The results of the tests were as follows: Three only agglutinated paratyphoid A + 1 in 25 and none paratyphoid B. In two of these paratyphoid A was isolated from the excreta—cases B. T. and A. L. (Table I); the third had evidently been infected with paratyphoid A because the typhoid titre was 1 in 250 and the paratyphoid A 1 in 50; six weeks later the typhoid was still 1 in 250, but the paratyphoid 1 in 25.

Of the remainder, six agglutinated typhoid 1 in 250 and two 1 in 500 +. Twelve, i.e., twenty per cent, agglutinated neither typhoid nor paratyphoid; eleven of these had been inoculated between May, 1914, and July, 1915. One had not been inoculated.

Results.

Clinical.

Seventy-eight per cent were admitted with a diagnosis of typhoid or enteric, and 22 per cent of paratyphoid, or stated that paratyphoid was a second diagnosis; four stated they were paratyphoid A and B. Ninety-three, i.e., 31 per cent, said that the first diagnosis was dysentery, while 112, i.e., 37 per cent, gave a history of severe diarrhœa with a passage of blood and slime, often with straining. Eighty-five per cent had apparently contracted "enteric" on the Peninsula, and the remainder in E., M., or elsewhere. Every case was also asked whether blood was taken from the arm, i.e., for blood culture; from the finger or ear on a slide, i.e., for malaria; or in a tube, i.e., for agglutination test.

The date of reporting sick, which was usually remembered to the very day, and the duration of the illness till they were allowed to get up for the first time, was also ascertained in each case. Thus we were able to obtain a rough idea of the date of the beginning of convalescence.

Of 260 men who were questioned 254 stated they had been inoculated against typhoid, 1 refused inoculation, 1 had not been inoculated, 4 were not sure; 40 men, all examined in November, were not questioned.

Six stated they had been inoculated against paratyphoid in 1915; 4 of them were inoculated in August or later, 3 at M., and 1 at A.; the details for the others were not ascertained. Three of these cases agglutinated typhoid and paratyphoid A only, 1 typhoid only, while 2 agglutinated neither typhoid nor paratyphoid A or B in 1 in 25.

We do not attach undue importance to the statements made by the soldiers, but must say that on the whole their answers were very intelligent and quite definite, much more so than those of the average hospital patients. Practically every one knew his maximum temperature, and knew whether he passed blood or slime. One or two were not quite certain whether their blood was examined, as they had been delirious. Hardly any knew whether their excreta had been examined, and, if so, with what results.

Serological.

Prophylactic typhoid vaccination almost always produces more or less typhoid agglutinins, which usually persist for months, or even years. Consequently, as Dreyer and his co-workers point out:—

(1) A serological diagnosis of active typhoid in the inoculated cannot be made without "two or more successive examinations" separated by "intervals of a few days" to see if any variation in the typhoid titre occurs.

(2) A serological diagnosis of active paratyphoid can be made in persons who have not been inoculated against paratyphoid by one examination only, for "agglutination in a dilution of 1 in 25 justifies a strong suspicion of paratyphoid infection" . . . "marked agglutination in a dilution of 1 in 50 or more is (nearly always) diagnostic of active paratyphoid infection" [19].

In almost all of our 300 cases the febrile period was passed, and *convalescence* well established; consequently the first of these principles will not apply. Dreyer [4], however, also states that in typhoid *convalescents* who had not been inoculated against typhoid, the typhoid agglutination titre "will always show a definite and measurable diminution of titre in the course of a week or two."

One would naturally therefore expect that in typhoid convalescents *who had been inoculated* against typhoid, the typhoid agglutination titre would also show a diminution in the course of a week or two, though the titre would not fall below the "higher base line" which is found in the inoculated.

One would also expect that the paratyphoid titre in paratyphoid convalescents would show a measurable diminution in a week or two.

Unfortunately, owing to war conditions, it has been impossible for us to test the agglutination titre of every convalescent on two or more occasions, and at the same intervals; nevertheless 216 were tested more than once, usually three or four times.

Tidy [16] has recently stated "there is evidence that marked pyrexia, perhaps 102° F., for five days is associated with diminution or complete disappearance of" typhoid inoculation agglutinins . . . "These agglutinins may return, but *usually do not*" (italics ours). He infers, therefore, that "a positive agglutination reaction to *Bacillus typhosus* after the fifth day of pyrexia has the same value in an inoculated as in an uninoculated person."

Tidy has published very little evidence in support of his rather revolutionary statements; besides, he employed a microscopic method, which is less accurate than the best macroscopic method. Dreyer, Gibson, and Walker [7] have just published figures which completely dispose of his main contention.

We ourselves estimated the typhoid agglutinins of fifteen inoculated soldiers taken consecutively who had suffered from pyrexia of at least 102° F., and for at least five days, due to lobar pneumonia, acute pleurisy, rheumatic fever, and surgical complaints; in three the pyrexia was still present at the time the blood was taken. All agglutinated typhoid in titres varying from 1 in 50 to 1 in 500!

It is possible, though not proved, that the general lowering of "resistance," which occurs in diseases associated with prolonged pyrexia, may sometimes temporarily diminish the titre of "inoculation" agglutinins. To act, however, on the assumption that a positive typhoid agglutination reaction has "the same value" in the inoculated as in the uninoculated might be disastrous for the Army—with all respect to Captain Tidy. Clearly, if the serological tests were believed, the "vast majority of febrile affections occurring in those recently inoculated against typhoid would "necessarily be diagnosed as typhoid"! [7]. In our opinion cases of dysentery with pyrexia from the Eastern Mediterranean were wrongly diagnosed as typhoid last summer, because it was not sufficiently realized how high the titre of typhoid "inoculation" might be.

Group I.

Cases agglutinating Paratyphoid A or Paratyphoid B.

Thirty-six cases agglutinating paratyphoid A, not paratyphoid B, and seventy-four cases agglutinating paratyphoid B, not paratyphoid A, were examined on one or more occasions.

The number of weeks after convalescence in which the first and last examinations were made are given. The typhoid agglutinins were estimated on the same number of occasions as the paratyphoid agglutinins, but as they rarely showed any change in titre only the first and last titres are given.

Comments.

Almost all, if not all, the cases in Tables A and B are examples of recent paratyphoid infection, for the following reasons :—

(1) (*a*) Eighty-six out of eighty-seven who were questioned stated they were inoculated against typhoid. No. 13 (paratyphoid A series) must, if his statement is correct, have had a mixed infection.

PARATYPHOID A SERIES.

	Paratyphoid A Agglutinins						Typhoid Agglutinins	
	Titre	Weeks	Titre	Titre	Titre	Weeks	Titre	Titre
1	250	13	125	50+	50	18	50	50
2	125	8	50	25	25	11	50	50
3	125	7	125	50	25	11	125+	125
4	125	3	250	50	50	7	25	50§
5	50+	3	50	125	50	7	50	50
6	50+	3	25+	50	25	7	50	50
7	50	11	50+	125	50	15	125	50
8	50	10	50	50	50	14	125	250
*9	25	7	25	25	25	11	125	250§
10	250	11	250+	125		15	50	50
11	125	5	25	0		9	125	125
12	125+	7	250	50		12	0	0
13	50	9	25+	0		16	250	125
14	50+	10	25	0		14	50	50
‡15	50	13	50	50		17	50	50
16	50	7	25	25		11	250	125
17	50	6	25	0		8	125+	125
18	25	11	12 ‖	0		17	50	50
*19	25	9	12 ‖	0		14	50	125§
20	250	5	25			12	0	0
21	250	4	250			10	25+	25+
22	125	2	25			9	125	125
23	125	4	50+			10	250	250
24	50+	5	0			12	0	0
25	50+	5	0			10	50	50
26	50	10	0			14	50	125§
27	50	3	0			7	250+	250+
28	25	6	50			9	125	125
29	25	9	0			11	25	0
30	25	9	0			11	125	125
31	25	6	0			9	250	250
32	125	Average 7·1 weeks.				Average 11·5 weeks	50	
33	50						125	
34	50	9					0	
35	50+	9					50	
36	25	3					125	
	Average 7·08 weeks							

* States was inoculated against paratyphoid, December, 1915, at Malta.

† States was not inoculated against typhoid.

‡ States was inoculated against paratyphoid, August, 1915, at Alexandria.

§ The rise in titre on second examination is due to alteration in the emulsion denominator from 5·6 or 6·3 to 7·7.

‖ Very few of the paratyphoid cases were tested in a dilution of 1 in 12 as well as 1 in 25.

PARATYPHOID B SERIES.

	Paratyphoid B Agglutinins						Typhoid Agglutinins	
	Titre	Weeks	Titre	Titre	Titre	Weeks	Titre	Titre
1	125	9	125	50	25	12	125+	125
2	125	9	50	50	50	13	125	50
3	125+	11	125+	250	125	15	250+	250
4	125	12	125	50	50+	16	125+	125
5	2500	0	125	50		8	50	50
6	125+	4	25	0		11	250	125+
7	50	13	25	0		16	250+	250
8	50	5	25	0		10	125	50
9	50	6	25	25		9	125	125
10	50	10	50	25		14	2500	2500
11	50	2	125	0		17	50	50*
12	25	12	25	0		16	25	0
13	2500+	0	250+			6	250	250
14	500	5	50			12	500	250+
15	500	10	250			14	500	250
16	250+	9	125			11	250+	500
17	250+	3	125			7	500	500
18	250	6	250			14	250+	500
19	250	7	25			11	250	250
20	250	2	50			5	250	250
21	250	9	0			13	125	125
22	250	7	25			12	250+	250
23	250	?	0			7	125	125
24	250	6	25			11	125	125
25	250	0	0			4	0	0
26	250	6	250	250		18	1250	500**
27	125	7	125			13	250	125+
28	125	8	250			12	250+	250
29	125+	2	0			5	50+	50
30	125+	7	0			12	250+	250+
31	125	3	0			6	50	50
32	125	6	25			9	250+	250
33	125	3	50			7	500+	500
34	125	10	50			14	250	250
35	125	8	50+			12	250+	250+
36	50	7	25			12	125	125
37	50+	3	0			6	250+	250
38	50	9	250			14	125	125
39	50	13	0			16	50	50
40	50	2	0			6	250+	250+
41	50	7	0			14	125	125
42	50	7	25			12	125	125
43	50+	2	0			6	50+	50+
44	50	6	0			12	50	50
45	50	3	0			10	250+	500
46	50	4	0			16	125	125
47	50	9	50			16	250+	250
48	50	11	50			16	1000+	–
49	25+	6	0			9	250+	250+
50	25	3	0			6	250+	250+
51	25	12	0			14	50	0
52	25	3	0			7	50+	50+
53	1250+	3	Average 6·3 weeks		Average 11·2 weeks		50	
54	500+	7					250	
55	500	7					250+	
56	250+	4					50	
57	250+	4					0	
58	250	7					50+	
59	250	7					250+	

PARATYPHOID B SERIES—*Continued.*

	Paratyphoid B Agglutinins						Typhoid Agglutinins	
	Titre	Weeks	Titre	Titre	Titre	Weeks	Titre	Titre
60	125	5					0	
61	125+	6					0	
62	125	11					250	
63	125	11					1250	
64	50	5					50	
65	50	9					25+	
66	50	10					250	
67	50	11					125	
68	50	7					250+	
69	25	?					125	
70	25	5					125+	
71	25	5					125	
72	25	8					250	
73	25	8					250	
74	25	11					500+	

Average 7·01 weeks

* Intermittent paratyphoid carrier (see p. 680).
** Chronic paratyphoid carrier (see p. 680).

(*b*) Only three out of the eighty-seven stated they were inoculated against paratyphoid; No. 15, August, 1915; No. 9 and No. 19, December, 1915 (paratyphoid A series). Probably they were mistaken, first because paratyphoid vaccine has only been used systematically this year, and second because none of the three agglutinated paratyphoid B which probably they would have done after a mixed vaccine of paratyphoid A and B, especially as the agglutination titre reached by paratyphoid B is on the average much higher than that for paratyphoid A when tested with the Oxford emulsions. After testing the serum reactions of at least 600 cases of dysentery and "enteric" we have so far found only three sera agglutinating *both* paratyphoid A and B; two had been inoculated with paratyphoid vaccine and the third apparently had not.

(*c*) Possibly, of course, one or two of the cases may have had paratyphoid fever before the War and the paratyphoid agglutinins have persisted and so misled us. There was, however, no clinical evidence of these attacks and the error from this cause must be negligible.

(2) If the typhoid agglutinins were due to typhoid inoculations several months ago, and the paratyphoid agglutinins to a paratyphoid infection a few weeks ago, one would expect the titre of the latter to diminish as a rule in the four weeks which elapsed between the two examinations, whereas the titre of the former would show little or no diminution, provided that the typhoid agglutinins were uninfluenced by paratyphoid co-agglutinins. That this is actually the case is shown in a remarkable manner in the next table.

TABLE.

CASES AGGLUTINATING PARATYPHOID AND TYPHOID, SHOWING THE PERCENTAGE IN WHICH THE TITRES OF PARATYPHOID AND TYPHOID REMAINED STATIONARY, ROSE, OR FELL BETWEEN THE FIRST AND LAST EXAMINATIONS.

Paratyphoid A first examined average 7·1 weeks after convalescence; last examined 11·5 weeks.

Paratyphoid B first examined average 6·3 weeks after convalescence; last examined 11·2 weeks.

	Paratyphoid				Typhoid			
	Number of cases	Stationary. Per cent	Rise. Per cent	Fall. Per cent	Number of cases	Stationary. Per cent	Rise. Per cent	Fall. Per cent
Paratyphoid A ..	31	19·4	3·2	77·4	28	82·1	3·7	14·2
,, B ..	52	11·5	4·0	84.5	50	76·0	6·0	18·0
,, A and B	83	14·5	3·6	81·9	78*	78·2	5·2	16·6

* This figure is reduced from 83 to 78 because four cases did not agglutinate typhoid 1 in 25, and one was tested only once for typhoid.

(*a*) The difference in the behaviour between the typhoid and paratyphoid agglutinins is even greater than shown in the table, because the typhoid titre fell markedly, i.e., more than one tube, in only 1·4 per cent, whereas the paratyphoid titre fell markedly in forty-eight per cent during approximately the same interval.

(*b*) Though the paratyphoid titre has fallen in the majority of cases and usually to a marked degree, there are a few, as one would expect, in which it has remained either stationary, Nos. 5, 6, 7, 9, 15, 21 (paratyphoid A series), Nos. 3, 18, 26, 27, 47, 49 (paratyphoid B series), or has fallen at first only, Nos. 1, 2, 16 (paratyphoid A series), Nos. 2, 9 (paratyphoid B series).

In this connexion it is interesting to note that those which remained stationary were first examined 8·2 weeks after convalescence, average interval 5·7 weeks; those which fell one tube 7·4 weeks, average interval four weeks; those which fell two or more tubes 5·5 weeks after convalescence, average interval 5·5 weeks.

It is remarkable that the titre of the paratyphoid "infection" agglutinins when first tested was usually less than that of the typhoid "inoculations" agglutinins, and also usually diminished rapidly and often disappeared, while that of the typhoid agglutinins showed no change.

Thus thirteen out of the thirty-one paratyphoid A cases, first examined 7·6 weeks after convalescence, failed to agglutinate para-

typhoid A 1 in 25 when examined again on the average four weeks later, and twenty-three out of fifty-two paratyphoid B cases examined 5·3 weeks after convalescence failed to agglutinate paratyphoid B 1 in 25, on the average 4·7 weeks later.

In other words, had the examination been delayed on the average from about seven to eleven weeks, two-fifths of the paratyphoid cases would not have been diagnosed by the technique we employed.

One would naturally have expected that the paratyphoid agglutinins, produced by a recent natural infection of some weeks duration with presumably large numbers of living bacilli, would have outlasted the typhoid agglutinins, produced several months ago by comparatively small doses of dead typhoid bacilli administered on two occasions only. The fact that typhoid vaccines are made from strains of bacilli selected partly on account of the capacity to form a large amount of inoculation agglutinins, may help to explain this phenomenon.

Our results however confirm the statement of the Medical Research Committee's leaflet, that the titre of paratyphoid "infection" agglutinins eventually falls "*below* the persistent base line of typhoid agglutination of inoculated persons." Peruzzi [14], who recently examined the blood of a number of officers thirty months after they had either suffered from typhoid or had been inoculated against that disease, found that the infection agglutinins were absent in sixty-three per cent, while the inoculation agglutinins were *present* in seventy-five per cent.

(*c*) The rise in titre in about five per cent of paratyphoid and typhoid cases is probably due to experimental error, except in the Cases 11 (intermittent carrier) and 38 (paratyphoid B series).

(3) *Co-agglutination* is in all probability not responsible for any of the paratyphoid titres in Group I; still its possible occurrence must be considered from three standpoints:—

(*a*) *Paratyphoid A producing co-agglutinins for paratyphoid B and vice versa.*—We have already mentioned that after examining the sera of nearly 600 dysentery and typhoid convalescents only three have been found agglutinating both paratyphoid A and B, in two of which the agglutination was we believe due to a dose of mixed vaccine.

Only one out of the four soldiers who said they were diagnosed as "paratyphoid A and B" agglutinated paratyphoid at all, and that paratyphoid B. They were examined on an average eight weeks after convalescence.

It is clear that the possibility of co-agglutination between

paratyphoid A and B may be disregarded in convalescence, at any rate when tested with the Oxford emulsions.

(*b*) *Typhoid producing co-agglutinins for paratyphoid A or B.*—Dreyer [6] states that a serum may "agglutinate *Bacillus typhosus* 1 in 500, 1 in 10,000, or even 1 in 200,000, and it will not agglutinate paratyphoid A or B as much as 1 in 10."

We found that the sera of twenty-five convalescent enterics with a typhoid titre ranging from 1 in 250 to 1 in 5,000, all failed to agglutinate paratyphoid A or B 1 in 25.

Co-agglutination cannot be of much importance in convalescence at any rate, since eighty-one per cent of the paratyphoid titres fell, and as a rule considerably, while in the same series only sixteen per cent of the typhoid titres fell, and as a rule slightly. In only thirteen per cent was the fall of paratyphoid and typhoid titres synchronous. Possibly the marked fall in paratyphoid titre in No. 13 paratyphoid A series, Nos. 6, 8 and 14 paratyphoid B series may have produced a slight fall in typhoid. Of course the fall in all may have been due to a mixed infection or the slow normal disappearance of "inoculation" agglutinins or technical error, such as insufficient serum to yield full-sized drops.

(*c*) *Paratyphoid A or paratyphoid B producing co-agglutinins for typhoid.*—Our figures demonstrate that a recent paratyphoid B infection certainly raises the titre of typhoid inoculation agglutinins; thus the typhoid titre was 250 or more in 51 per cent of the paratyphoid B series, whereas the same titre was reached in only 14 per cent of the paratyphoid A series, and 20 per cent of 162 cases which agglutinated neither paratyphoid A nor paratyphoid B (see Group III).

According to Dreyer [5] active paratyphoid infection *may* produce a rise in inoculation typhoid agglutinins, though in the great majority the "first group agglutination took place in dilutions considerably greater than 1 in 1,000."

He also says "that both the frequency in which the rise of typhoid agglutinins occurs and its extent are usually much less evident in paratyphoid A infections than in paratyphoid B infections." Our figures confirm this as far as paratyphoid B is concerned.

If the paratyphoid B infection raises the titre of the typhoid inoculation agglutinins one would expect the subsequent fall in eighty-four per cent of the paratyphoid B titres to be accompanied by a similar fall in typhoid titres.

In reality the typhoid titres in the paratyphoid A infection fell

in fourteen per cent, but those in the paratyphoid B infection fell in only eighteen per cent between the two tests.

This remarkable discrepancy can be explained by observations made by Dreyer and Walker [17], who found "if an animal which has been immunized some weeks or a month or two before with a particular micro-organism be inoculated with a non-lethal dose of a vaccine prepared from some other micro-organism its agglutination titre for the first micro-organism exhibits a new rapid rise of greater or less extent and pursues a curve similar to the ordinary inoculation curve." In other words, under the stimulus of the paratyphoid B infection the typhoid agglutinins have in most cases repeated the *sudden* rise and *very slow* fall which they underwent after the original typhoid inoculation. This increase is "due to a reaction of a general non-specific character affecting cells and tissues which are already engaged in the formation of specific agglutinins and causing them to take on the increased activity" [3].

(4) We believe a paratyphoid titre as low as 1 in 25 is probably always diagnostic of paratyphoid infection in convalescents at any rate, provided that paratyphoid vaccine has not been used: first because such titre was never present in the various controls, and second, because in many of the cases in Group I the titre of 1 in 25 disappeared without any corresponding change in the typhoid titre, e.g., Nos. 11, 14, 18, 30, etc., paratyphoid A series, Nos. 7, 49, 50, paratyphoid B series.

We found the titre of paratyphoid B agglutinins as a rule much higher than that of paratyphoid A; thus only eleven per cent of the latter cases reached a maximum of 250, but thirty per cent of the former reached from 250 to 1,250, including two of 2,500, though these last were tested at the very beginning of convalescence.

If the results were expressed in "standard agglutinin units" the paratyphoid B titre would be still higher, e.g., one batch of emulsion gave with a titre of 250 paratyphoid A 70 units, paratyphoid B 93 units.

We conclude, therefore, that a paratyphoid A titre of 1 in 25 is more significant than a paratyphoid B titre of the same amount. Dreyer, as stated before, believes a titre of even 1 in 10 is diagnostic of paratyphoid A.

Our figures of "infection" agglutinins confirm those of Dreyer, also of Coppinger and Gibson [2] with "inoculation" agglutinins. These observers found independently that after inoculation with a mixed paratyphoid vaccine the paratyphoid B titre was much higher than the paratyphoid A titre. Castellani's [1] figures show

that after his vaccine the titre of paratyphoid A and B is practically the same. Harvey and Gibson [9], on the other hand, found the titre of paratyphoid A higher and more persistent than paratyphoid B, but they inoculated rabbits.

The relative position, however, of the paratyphoid A and paratyphoid B titre in a given series of cases will depend not only on the quantity of specific agglutinins and their persistence when formed, but also upon the relative agglutinability or *sensitiveness* of the emulsions used to measure those agglutinins.

Paratyphoid Carriers. — The relation between paratyphoid carriers and paratyphoid agglutinins is well shown in Cases 26 and 11. No. 26 is a chronic paratyphoid carrier; the fæces were examined on seven occasions and the MacConkey's plates invariably yielded large numbers of non-lactose fermenting colonies which proved to be paratyphoid B. The patient's serum examined on several occasions showed no change in twelve weeks in paratyphoid B titre, whereas the typhoid titre diminished.

No. 11 is an intermittent paratyphoid B carrier; the titres were as follows: Two weeks after convalescence paratyphoid B. 50; typhoid 50; five weeks paratyphoid B 125, typhoid 50; seventeen weeks paratyphoid B 0, typhoid 50. The excreta were examined on four occasions up to this date with negative results; twice the plates contained a few non-lactose-fermenting colonies, which proved negative. Nineteen weeks after convalescence the plates showed ninety-five per cent of non-lactose-fermenting colonies; paratyphoid B found. Twenty weeks paratyphoid B, titre 0, typhoid + 50; twenty-one weeks after convalescence the plates showed 75 per cent non-lactose fermenting colonies, paratyphoid B found. Paratyphoid B, titre + 125, typhoid 250.

In the Medical Research Committee's pamphlet it is stated: "A *non-inoculated* carrier (typhoid or paratyphoid) will normally show no important change in the titre of his serum on repeated examination at short intervals." It is evident that a carrier may show an important change in titre; perhaps, however, the word "normally" excludes intermittent carriers.

The Relative Frequency of Typhoid, Paratyphoid A and Paratyphoid B.—Bassett-Smith [15] states the percentage of naval cases at Plymouth to be "11 per cent of true typhoid," "40 per cent paratyphoid A, 20 per cent paratyphoid B, while 29 per cent were indefinite." He himself found "12 per cent typhoid, 14 per cent paratyphoid A, 36 per cent paratyphoid B, and 30 per cent uncertain."

Grenet and Fortineau [8], examining French soldiers—whether from the Mediterranean or France is not mentioned—found in 90 positive blood cultures that 76 were paratyphoid A (2 deaths), 12 paratyphoid B (1 death), and 2 typhoids (1 death).

Kenny [11], amongst the Canadian troops at Taplow, found 11 cases probably typhoid, 22 cases in which the diagnosis of paratyphoid B, and 3 in which the diagnosis of paratyphoid A had been established.

Ledingham and Penfold [12], examining cases from the Near East, found by cultures paratyphoid A 22 cases, paratyphoid B 2 cases, typhoid 3 cases, and by serum reactions paratyphoid A 15 cases and paratyphoid B 8 cases.

Archibald's results of blood cultures at the Mudros hospitals gave typhoid 19, paratyphoid A 67, and paratyphoid B 41 cases, and non-agglutinable paratyphoid cases 14.

All the statistics from the Near East, whether from cultures or serum tests—the results of the two methods will not necessarily coincide—show that paratyphoid A was much more frequent than paratyphoid B. We found the reverse, thirty-six cases paratyphoid A and seventy-four paratyphoid B. The discrepancy may be partly explained by supposing that the paratyphoid B agglutinins on account of their higher original titre persist longer than those of paratyphoid A, though we have no evidence of this.

There is, however, a very simple explanation. Willcox [18] referring to Archibald's figures, which gave the largest number of typhoid and paratyphoid cases, proved by blood cultures from the Near East, says "that up to the end of October, 1915, paratyphoid B was much more frequent in occurrence than A, but after the end of October paratyphoid A was much more common." We have arranged 107 of our cases in which the date of onset of paratyphoid fever could be approximately fixed; the results are given below:—

TABLE.

Date of onset	Number of cases	Ratio of paratyphoid A to paratyphoid B	
August and September ..	58	1	4·9
October	16	1	1·7
November	18	1·2	1
December and January..	15	1·5	1

When it is remembered that all our cases were diagnosed with exactly the same technique, and under the same conditions, the

results confirm Willcox's statement in a striking manner. It appears that paratyphoid B infections, though rare, are much commoner than paratyphoid A infections in Europe, especially in England, whereas in India the reverse obtains. The change in the incidence of these two diseases among the troops in the Eastern Mediterranean last October is probably due to the fact that a large number of battalions from India were brought there, some of which would be infected with paratyphoid A.

Group II.

Cases failing to agglutinate Typhoid, paratyphoid A or paratyphoid B 1 *in* 25 *at the First Examination.*

Twenty-eight cases, i.e., 9·3 per cent, comprised this series. The agglutination reaction was tested on the average seven weeks after the onset of convalescence, maximum twelve and nine weeks, minimum nil and two weeks. Twenty-six had been inoculated against typhoid between May, 1914, and December, 1915; the average time from inoculation was ten months; one refused inoculation and one was not questioned, two stated they were also inoculated against paratyphoid. Two were diagnosed as paratyphoid and one as "paratyphoid A and B."

Comment.

The majority of these patients probably never had typhoid, because even if the inoculation agglutinins had disappeared in about ten months, it is unlikely that the typhoid infection agglutinins would have disappeared in about seven weeks, especially as eight of the cases were tested three weeks or less after the onset of convalescence. Again, blood cultures appear to have been made in only one case, and serological tests in eight. Lastly, twelve gave a history of and were first diagnosed as dysentery and one of malaria.

Group III.

Cases agglutinating Typhoid only.

It has already been pointed out that a serological diagnosis of typhoid cannot be made in those recently inoculated, unless the titre of the typhoid agglutinins is estimated on two occasions at least, if not three or more, separated by short intervals.

Unfortunately, it was only possible to do this in 133 out of the 162 cases in this group.

The results are taken collectively and summarized; in a few

instances, however, individual cases have been alluded to. The results are arranged in three series: (*a*) ninety-five cases examined on three or more occasions; (*b*) thirty-eight cases examined on two occasions only; (*c*) twenty-nine cases examined only once. Those of the first two series are tabulated below:—

TABLE.

CASES AGGLUTINATING TYPHOID ONLY, SHOWING THE PERCENTAGE IN WHICH THE TITRE WAS STATIONARY, ROSE OR FELL BETWEEN THE FIRST AND LAST EXAMINATIONS.

	Stationary, per cent	Weeks from convalescence	Weeks between tests	Rise per cent	Weeks from convalescence	Weeks between tests	Fall per cent	Weeks from convalescence	Weeks between tests
Series A, 95 cases	67·4	8·9	4·7	9·4	7	4·3	23·2	7	5·8
Series B, 38 cases	57·8	5·9	3·8	10·6	7·5	3·5	31·6	7·4	3·4
Series A and B, 133 cases	64·7	8·1	4·4	19·8	7	4	25·5	7·1	4·8
Typhoid in Paratyphoid A and Paratyphoid B table	78·2	6·2	4·4	5·2	7	5·2	16·6	8·1	6
Paratyphoid A and Paratyphoid B table, 110 cases	14·5	8·1	5·9	3·6	7·7	4	81·9	6·3	4·5

Comments.

(1) The titre (Series A and B) on the first examination was 500 to 2,500 in 2·3 per cent, 250 in 19·6 per cent, 125 in 36·1 per cent, 50 in 27 per cent, 25 in 15 per cent.

(2) In sixty-four per cent (Series A and B) the typhoid titre was stationary between the two examinations, which is a strong evidence that the majority never had a recent typhoid infection. This is corroborated by the fact that the percentage in which the titre was stationary is only a little less than that of the typhoid titres in the *paratyphoid* series, where we believe a recent typhoid infection had rarely if ever occurred. It forms a marked contrast to the small percentage of stationary paratyphoid titres in the same series, where we believe a recent paratyphoid infection had almost always, if not invariably, occurred.

(3) Thirty-four cases or 25 per cent showed a fall in titre. They were arranged according to the number of weeks, the first examination was made after convalescence; 46 per cent fell in the first four weeks after convalescence, 29 per cent in the second four weeks and 20 per cent from nine to eighteen weeks. In other words, had the first examination been made sooner, a larger proportion of cases would most probably have shown a fall in titre which could be evidence of a recent typhoid infection.

This fall in titre, however, is not really strong evidence of a recent typhoid infection—because only seven—i.e., 5·3 per cent fell as much as *two* tubes, whereas in the paratyphoid series forty-eight per cent fell *two* or even more tubes, in approximately the same time.

Six cases (Series A) showed a steady fall in the titre of at least two tubes, which, as they had all been inoculated against typhoid more than a year before, was in our opinion conclusive evidence of a recent typhoid infection:—

TABLE.

TYPHOID AGGLUTININS.

	Titre	Weeks	Titre	Titre	Weeks
1	250	4	125	50	9
2	250+	4	125	50	11
3	250	7	125	25	13
4	250	3	125	50	12
5	50	6	25	—	15
6	50	4	25	—	7
	Average ..	4·7		Average ..	11·2

The seventh (Series B), first examined six weeks after convalescence, showed a titre of 50, which fell to 0 in seven weeks; this also was probably a case of typhoid infection.

Of the remaining twenty-seven of both series, all fell only one tube. As the fall was so slight, it is in the majority of cases most probably due to a gradual normal disappearance of inoculation agglutinins, or to technical error, and not to active typhoid infection.

(4) Thirteen, or ten per cent, showed a rise in titre; in three (Series A) the titre rose steadily.

No. 7, titre 25 (four weeks after convalescence), 125 (5), 250 (7), 50 (9), 50 (10). Inoculated against typhoid October 1914. The

emulsion denominator was 5·6 for the first test and 7·7 for all the rest.

No. 8, titre 250 (nine weeks after convalescence), 500 (10), 1,000 (11), 500+ (13), 500 (15). Inoculated against typhoid October, 1914. The emulsion denominator was 7·7 for all tests. No. 9, titre 50 (six weeks after convalescence), 125 (7), 125 (8), 250 (10), 500 + (14), 500 + (16). Inoculated against typhoid May, 1915. The emulsion denominator was 5·6 for the first test and 7·7 for all the rest.

It will be noted that in 7 and 8 the typhoid titres steadily rose and subsequently fell, in 9 there was a steady rise and no subsequent fall in sixteen weeks. In our opinion this change in titre, although it was unassociated with any pyrexia, is conclusive evidence of recent typhoid infection. It suggests the possibility that the patients are carriers, at any rate in Case 9, but no typhoid bacilli have been isolated after at least four examinations of the excreta. If these cases were typhoid, then the typhoid agglutinins in typhoid convalescents do not "*always* (italics ours) show a definite diminution of titre in the course of a week or two" as one is led to infer from Dreyer's statement [4].

Of the remaining ten, three rose two tubes, in one probably from infection, and the other two from technical error or change of emulsion denominator.

(5) Other remarkable evidence strongly suggests that very few in this group really had typhoid, viz., the typhoid titre reached 250 or more in only twenty per cent of the cases, whereas it reached this limit in fifty-one per cent of the paratyphoid B series, the rises being due to co-agglutination, and not typhoid infection. One would naturally expect, had typhoid infection really occurred, that the titre would have reached at least 250 in far more than fifty per cent of the cases.

Dreyer [4] found the titre greater than 1 in 500 in seven out of eight consecutive cases of active typhoid infection, even though the patients had never been inoculated.

Series C.—Of the 29 cases examined once, 3 agglutinated 1 in 500; 6, 1 in 250, and the remainder varying from 1 in 125 to 25.

Summary.—We have briefly summarized the results, though the data are sometimes incomplete. In only eleven cases was there a strong probability, if not a certainty, of recent typhoid infection. Even if we assume that as many as half the remaining twenty-five cases, in which the titre fell one tube, were also infected, the total reaches twenty-four cases, i.e., about ten per cent of the whole 300

examined. This forms a marked contrast to the thirty-seven per cent of cases agglutinating paratyphoid; two or three of the latter, however, may have been infected with typhoid as well. The number of typhoid infections would probably have slightly increased if the twenty-nine cases (Series 3) had been examined at least twice.

The number of typhoid infections would also have been increased if the first examination had been made earlier than an average of seven weeks after the beginning of convalescence, but so would the number of paratyphoid infections. Our proportion of 1 typhoid case to not less than about 4 or 5 paratyphoid cases is corroborated by Archibald's figures from blood cultures—19 typhoids to 122 paratyphoids, and our own from the excreta of convalescents—2 typhoids to 12 paratyphoids.

Last summer the diagnosis of typhoid was often made in the Eastern Mediterranean on insufficient clinical and bacteriological evidence.

(*a*) Patients with continued "pyrexia of unknown origin" were called enteric just as they were called "influenza" in England or "malaria" in India.

The clinical diagnosis was especially difficult because fully a third were suffering from acute dysentery.

There have been cases labelled "convalescent dysentery" from the Eastern Mediterranean at the Tropical School Auxiliary Military Hospital, Liverpool, under the care of Professor Stephens and Captain L. Morgan, which have developed "pyrexia of unknown origin" lasting days or weeks, but without serological or bacteriological evidence of typhoid or paratyphoid infections.

(*b*) The bacteriological evidence was insufficient, because of 154 patients of the 163 in this group who were questioned, only eight per cent stated that blood was taken from their arms, i.e., for cultures—an operation likely to be remembered. Only forty per cent had blood taken from their fingers or ears, i.e., for serum reaction, though a *single* examination is perfectly useless in the diagnosis of typhoid among the inoculated. A great improvement has now been made in the bacteriological diagnosis, for in a large series of "enteric" cases not included in this paper, which have recently arrived from the Eastern Mediterranean, practically all of whom contracted the disease this year, thirty-four per cent gave us a history of blood cultures and forty-five per cent of serological tests.

SUMMARY AND CONCLUSIONS.

(1) The serum reactions to typhoid, paratyphoid A and paratyphoid B of 300 consecutive recently convalescent "enterics" from the Eastern Mediterranean, have been tested by Dreyer's technique, and with emulsions supplied by the Oxford Standards Laboratory through the agency of the Medical Research Committee.

(2) After making about 3,000 tests of these and other cases, we find the emulsions most satisfactory, giving quite clear and definite readings, and the technique so simple that it can easily be mastered by an intelligent attendant. The method is accurate, the margin of error small, and eminently suitable for routine work on a large scale. It is essential, however, to have the same intensity of artificial illumination by day and night for reading the titres.

The only practical difficulty, viz., that of obtaining sufficient blood, was overcome by instructing the ward sisters how to fill specially made Wright's capsules.

(3) Control sera of soldiers inoculated against typhoid, but suffering from dysentery or surgical diseases, failed to agglutinate either paratyphoid emulsions, but the serum of every convalescent, twelve in all, excreting paratyphoid A or paratyphoid B bacilli, agglutinated the corresponding emulsion only, in titres ranging from 25 to 250.

(4) One hundred and ten, or thirty-seven per cent, of the cases tested agglutinated paratyphoid emulsion. Thirty-six agglutinated paratyphoid A (titre from 25 to 250), and seventy-four paratyphoid B (titre from 25 to 2,500). They were first tested about seven weeks after the onset of convalescence. As none, with three doubtful exceptions, had been inoculated against paratyphoid, almost all, if not all, had a recent paratyphoid infection.

This is confirmed by the fact that eighty-three cases were tested at least twice, and the paratyphoid titres, presumably from "infection," fell during 4 weeks in 82 per cent; 48 per cent fell markedly; 43 per cent completely failed to agglutinate at the last test, i.e., would never have been recognized as paratyphoid had the first test been delayed from about seven to eleven weeks after the onset of convalescence. Occasionally the fall in paratyphoid titre was rapid at first, and then slower or ceased altogether.

The typhoid titre, presumably from "inoculation," fell in only seventeen per cent of cases; only 1·4 per cent fell markedly.

(5) The remarkable diminution and frequent disappearance of the paratyphoid "infection" agglutinins, which usually occurred, formed a marked contrast to the stationary typhoid "inoculation"

agglutinins. This is partly explained by supposing that the typhoid vaccines were made from strains of bacilli, especially selected on account of their capacity to form quantities of "inoculation" agglutinins.

(6) *Co-agglutination:* (*a*) Between paratyphoid A and B or vice versa, did not occur with the Oxford emulsions, in convalescence at any rate; only three sera out of 600 have agglutinated A and B simultaneously, in two paratyphoid vaccine had been used. (*b*) Typhoid infection or vaccine produced titres from 250 to 2,500 without agglutination of paratyphoid. (*c*) Paratyphoid B infection, though not paratyphoid A infection, certainly raised the titre of typhoid inoculation agglutinins. It was remarkable, however, that the paratyphoid B titre usually fell while the typhoid persisted; apparently the paratyphoid B infection stimulated the tissues already engaged in the formation of typhoid agglutinins to repeat the sudden rise and gradual fall which followed the typhoid vaccine.

(7) The paratyphoid A titre averaged a lower level than that of paratyphoid B, after infection and after vaccine, partly perhaps because the paratyphoid A emulsions used to demonstrate the presence of agglutinins were relatively less sensitive. Consequently a low paratyphoid A titre is the more significant. Dreyer, in fact, states that an agglutination of 1 in 10 paratyphoid A is diagnostic.

(8) In a persistent paratyphoid B carrier the paratyphoid titre showed no change in four months, whereas in an intermittent paratyphoid B carrier the titre varied considerably.

(9) Our serological tests independently confirm what Archibald found by blood cultures, viz., that in the Eastern Mediterranean paratyphoid B infections were commoner than paratyphoid A until in November, after which the reverse obtained. This change in incidence was probably due to the introduction of paratyphoid A carriers with the battalions from India.

(10) Twenty-eight cases—i.e., 9·3 per cent—failed to agglutinate typhoid, paratyphoid A, or paratyphoid B 1 in 25 when tested about seven weeks after the onset of convalescence; all but two had been inoculated against typhoid. The majority probably had never had typhoid, partly because one-third were tested three weeks or less after convalescence, and blood cultures appear to have been made in only one instance.

(11) One hundred and sixty-two cases agglutinated typhoid alone, and were examined on the average eight weeks after the onset of convalescence. Of 133 examined at least twice, eleven showed a marked fall or rise in titre, demonstrating that almost

all, if not all, had a recent typhoid infection. But even including doubtful cases, not more than ten per cent of the 300 showed evidence of recent typhoid infection. This percentage, however, would have been increased, had the first examination taken place sooner; but so also would the percentage of paratyphoid cases.

(12) The number of typhoid cases is evidently small because: (*a*) A fall in titre occurred in only twenty-five per cent (five per cent marked); this agrees with the behaviour of the typhoid "inoculation" agglutinins in the paratyphoid group, which fell in seventeen per cent (one per cent marked), and contrasts strongly with that of the paratyphoid "infection" agglutinins which fell in eighty-two per cent (forty-eight per cent marked).

(*b*) The typhoid agglutinins reached a titre of at least 250 in only twenty per cent of cases. This is exceedingly small if typhoid infection had actually occurred, for the typhoid "inoculation" agglutinins reached the same limit in fifty-one per cent of the paratyphoid B series—though this high level is presumably due to co-agglutination—and in fourteen per cent of the paratyphoid A series.

(13) The diagnosis of typhoid in the Eastern Mediterranean last summer was less reliable than usual, because pyrexia of unknown origin is frequent in hot climates, besides fully a third of the cases were suffering from acute dysentery; and lastly, because it was only controlled by blood cultures in about ten per cent. Serological controls were carried out in forty per cent; but such are useless and misleading in the "inoculated" unless repeated at intervals, and there is no evidence that this was done.

(14) The diagnosis of "enteric" in cases not suffering from these diseases vitiates treatment and discredits prophylactic vaccination, while those who recover are regarded as potential bacillary carriers, and prevented from returning to active service for months.

(15) The prophylactic use of mixed paratyphoid vaccines will, undoubtedly, increase the difficulty of diagnosing paratyphoid, as typhoid vaccine has done in the case of typhoid. The difficulty will be greatest in those mild cases which occur, especially in the partly protected, where the infecting bacteria cannot be demonstrated. Repeated serological tests will be of great assistance in the diagnosis. The most suitable method for routine work in war time is Dreyer's, with the Oxford emulsions. It possesses the additional advantage of being a successful attempt to standardize the agglutination tests, and thereby make the results from different laboratories strictly comparable.

(16) As far as our opportunities have permitted, we have confirmed all the statements of the Medical Research Committee's leaflet, with one minor exception.

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THE DETERMINATION OF SUGAR IN THE BLOOD.

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There is reason to believe that the accurate determination of the concentration of sugar in the blood would assist in the differential diagnosis of certain conditions brought about by exposure to great mental excitement.

As our knowledge has accumulated regarding the connexion between the concentration of sugar in the blood and the mental state of the individual, investigators have become more cautious in relating sugar content with the previous history of the patient, without taking into consideration the psychic condition at the time the blood was drawn.

That glycosuria in animals is produced by fixation has been known since the time of Claude Bernard, but clinicians have only recently had their attention drawn to the changes which mental excitement may cause in the concentration of sugar in the blood.

It would appear that any stimulation of the chromaffine system reacts secondarily on the pancreas, whereby glucose is mobilized for immediate use. The very interesting and important considerations of Cannon, in which he brings fear, anger and physical effort into relation through the medium of the sympathetic system, are founded on these discoveries.

Conversely, in any estimation of sugar in the blood, one must be extremely careful that all operative procedures are of so simple a character as to disturb the patient's mental state as little as possible. For this reason, the method proposed by Bang,[1] whereby the total amount of blood required for an estimation is less than 0·15 gramme, stands in a place by itself.

The operative procedure is that of a blood count, so that this method is certain to produce less mental change in a patient than would be caused by venipuncture, and this difference will be more pronounced in patients whose threshold to external stimuli is already lowered.

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[1] Bang, *Der Blutzucker*, Wiesbaden, 1913, pp. 20 *et seq.* Also *Biochemische Zeitschrift*, 49, 19, 1913, and 57, 300, 1913.

At the present time, the limit of accuracy of methods for determining sugar in blood, using quantities as large as two to five cubic centimetres, is about ten per cent, and an examination of Bang's papers on the subject will show that his results are concordant to about the same degree. The present writers, and others who have used his method carefully, are in substantial agreement on this point.

For example, if 0·1 milligram of sugar is estimated by Bang's method, it will produce a quantity of cuprous salt which will require about 0·5 cubic centimetre N/200 iodine solution for titration. If the successive titrations for the above quantity of sugar are concordant to two drops, each of approximately thirty milligrams in weight, the maximum difference between two results would be about ten per cent. But, although Bang's method can be used with very small amounts of blood, and is easily carried out, it is open, according to our experiences with it, to several defects which seriously limit its accuracy.

In the first place, the end-point of the titration, the change of the light-blue colour of the copper salt to the darker blue produced by the action of iodine on starch is not particularly easily seen, and is very fugitive. This rapid falling off in intensity of the iodine-starch-blue colour, which marks the end of the titration is probably due, at least in part, to the fact that the oxidation of the cuprous salt by means of iodine only takes place in alkaline solution. The alkaline copper solution used in Bang's method contains sodium carbonate, and the action of this substance is probably accountable for the fugitive nature of the end-point. Secondly, in a series of, say, ten estimations, one or two results will often be found to diverge considerably from the remainder; this divergence indicating a greater content of sugar in the blood in these particular cases (*vide* Series of Experiments 6, 7, 8, pp. 702 and 703). This seems to us to be due, in most cases, to differences in the papers used for the absorption and weighing of the blood.

If a series of blank experiments be made, using the papers alone, without blood, similar divergences sometimes occur. This might be due to traces of starch, which if it became hydrolysed to sugar, would account for the higher results occasionally obtained. In an attempt to avoid this difficulty, we extracted a number of papers with very dilute acetic acid and obtained rather more concordant results by using them.

Better results were also obtained by absorbing the blood by means of carefully purified asbestos instead of paper, but the

practical difficulties of filtration, etc., made this method too laborious (Series 8, p. 703). As we shall show, we have found that glass wool may be used instead of paper, and with this material we have obtained satisfactory results (Series 3, p. 701).

Thirdly, the conditions of heating the blood-sugar with the copper solution are not entirely satisfactory and are capable of improvement.

It has been recognized for many years that the method of heating Fehling's solution with a known amount of reducing sugar has an effect on the amount of cuprous oxide produced, and for that reason, in the more accurate methods for the determination of glucose there is a definite time fixed for the duration of boiling. Bang, however, lays great stress on the time which the solution should take to reach the boiling-point, while the time during which the solution is kept boiling is fixed at two minutes. This author also considers the time taken to reach the boiling-point as very important. Those who have paid attention to getting the best possible results with Bang's method realize that this is entirely the case, but no explanation seems to have been given.

It would appear that two reactions are going on during the preliminary heating. In the first place, there is the formation of cuprous salt with simultaneous oxidation of the glucose. At the same time, however, part of this cuprous salt produced is being re-oxidized by free oxygen dissolved in the solution, or in the air at the free surface of the liquid. This re-oxidation could only take place to any extent in the period preliminary to boiling, for as soon as the liquid boiled vigorously the free oxygen would be expelled by steam.

The reduction of the copper solution by the glucose begins, however, before the boiling-point is reached, so that there is ample opportunity for this re-oxidation to take place, and the extent to which it would occur would partly depend on the length of the preliminary period before boiling began.

If a series of several estimations is to be made it is very difficult, or nearly impossible, to arrange the experimental conditions so that this preliminary time of heating is the same in each case. The effect of this re-oxidation would not be noticeable if the amount of sugar were large, but when it is small, and the total amount of cuprous salt produced is less than a milligramme, it can exert a considerable influence on the results.

This re-oxidation by free oxygen is probably much more important when the cupric compound is reduced to a cuprous salt

which remains in alkaline solution (as is the case in Bang's method), than when it is deposited as insoluble and stable cuprous oxide, as in the ordinary estimation of reducing sugars by Fehling's solution.

Bang directs that the time of heating preliminary to boiling should be kept to 1 minute, 30 seconds, $\pm$ 5 seconds, but even with a good pressure regulator it is very difficult to ensure this condition when making a series of determinations in different flasks, as the thickness of the glass, and therefore the rate at which heat is conducted, is not the same in each case.

We have endeavoured to avoid this difficulty by shortening the time of preliminary heating as much as possible. The small Erlenmeyer flasks in which the liquid is contained are held in a pair of tongs over a naked Bunsen flame, and as soon as they begin to boil are placed on a tray containing coarse aluminium powder (a small sand-bath would serve instead) heated by a flame sufficient to keep the liquid boiling.

In this way, the preliminary heating period before the boiling-point is reached is reduced to about 25 seconds, and is very fairly constant.

As we have pointed out that the end-point in Bang's method is in our experience unsatisfactory, we at first endeavoured to improve it by alterations in the composition of the copper solution and also in the conditions of the titration, whilst using the same general reaction; that is, the oxidation of an alkaline cuprous solution to the cupric state by means of iodine, excess of iodine being indicated by means of starch.

In particular we used the liquid obtained by adding excess of sodium pyrophosphate to copper sulphate solution (the precipitate of cupric pyrophosphate first obtained dissolves easily in excess of sodium pyrophosphate), the liquid being then rendered more alkaline by the addition of potassium carbonate and bicarbonate. Solutions such as these led, in some cases, to some improvement in the stability of the end-point, but at the same time had usually a lower reduction-factor, and so were not markedly better than Bang's solution.[1]

Another modification of Bang's method was also used, and although more complex, gave a better end-point, though it was not

[1] The liquid obtained by adding sodium pyrophosphate in excess to copper sulphate solution, then caustic soda, is a sensitive reagent for reducing sugars and will keep indefinitely. It might be of some use as a one-solution form of "Fehling's solution."

nearly so stable as the end-point in the titanium trichloride method, which we finally adopted, and which is described below.

In this case the liquid after heating was acidified with acetic acid and excess of potassium iodide added. In the acid solution the cupric salt remaining liberates an equivalent amount of iodine (the reverse of the action in alkaline solution, when the cuprous salt is oxidized to cupric by iodine) and is reduced to the cuprous state. The liberated iodine is then titrated with thiosulphate, starch being used as indicator. It is necessary to pass hydrogen through the flask during titration to prevent atmospheric oxidation. The amount of copper solution used must also be accurately measured, as it is the unreduced cupric salt which is determined. We obtained good results by this method, but the end-point is not sufficiently stable, and practice is required to observe it accurately. (For results *see* Series 9, p. 703.)

Titanium Trichloride Method.

The method described below, using titanium trichloride, is the one we have found the most serviceable, as the end-point is stable and free from doubt. It depends upon the following reactions:—

Titanium trichloride (which can be bought in fifteen to twenty per cent solution) is an exceedingly vigorous reducing agent. It reduces cupric and ferric salts to the cuprous and ferrous states immediately, being itself oxidized to the tetrachloride. If then a known amount of the trichloride be added in excess to a cupric solution, the cupric salt will be entirely reduced to a cuprous state, and an equivalent quantity of titanium trichloride oxidized to the tetrachloride. The excess of trichloride can then be estimated by running in from a burette a known solution of ferric chloride. Ammonium or potassium thiocyanate is used as the indicator, as the soluble thiocyanates give a deep red colour (ferric thiocyanate), with minute amounts of ferric salts, and no colour with ferrous salts. So long, therefore, as any titanium trichloride remains, this colour will not be produced, for the ferric salt would be immediately reduced to ferrous, but so soon as the whole of the titanium trichloride has been oxidized the slightest excess of ferric salt will produce the red colour. The red colour thus produced does not tend to disappear, and the reaction is as sensitive as the starch-iodine reaction, if not more so, so that the end-point is at once stable and very delicate. The method is virtually an oxidation of the cuprous salt produced by the sugar to cupric salt by means of ferric chloride, the titanium trichloride being interposed to make

the reaction rapid and complete. It must be present, as the direct oxidation of the cuprous salt by ferric salt is not feasible.

The method is thus at a disadvantage as compared with Bang's method in that it is indirect, and that it involves accurate measurement of both the cupric solution and the titanium trichloride, but these measurements can easily be made, and the indirect nature of the method is more than compensated for by the stability of the end-point and the consequent accuracy.[1] (For experimental results, *see* Series 1 to 5, pp. 700 to 702.)

Details of the Method.

Preparation of the Solution.—The potassium chloride solution is made by dissolving 220 grammes of pure KCl in distilled water, filtering, adding eight cubic centimetres of N hydrochloric acid, and making up to one litre. It is important to use as pure KCl as possible, as impure specimens contain reducing substances.

Copper Solution.—Instead of Bang's carbonate-bicarbonate solution, we use ordinary Fehling's solution diluted, as it gives a larger reduction factor. Ten cubic centimetres of each Fehling's solution are mixed and made up to 100 cubic centimetres ; it should be made up as required.

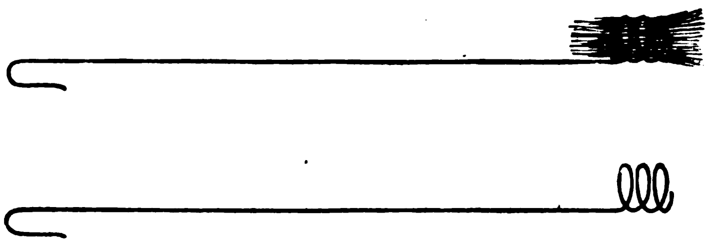
Titanium Trichloride Solution.—This is made up and stored as described in Knecht and Hibbert's "New Reduction Methods in Volumetric Analysis," pp. 46 to 47. Fifty cubic centimetres of commercial $TiCl_3$ solution (approximately twenty per cent) are boiled for about a minute with 100 cubic centimetres of concentrated HCl. The mixture is then made up to two litres, and placed in a storage bottle—which it practically fills. This is connected with a small hydrogen generator and a burette of ten cubic centimetres divided into tenths of a cubic centimetre, arranged as shown in Knecht and Hibbert's book.

Method of taking and weighing the Blood Sample.—If only a

[1] We found, after having worked out the method and used it to a considerable extent, that experiments on the estimation of glucose by a similar method had been made by Knecht and Hibbert "New Reduction Methods in Volumetric Analysis." E. Knecht and E. Hibbert. Published by Longmans, Green and Co. These authors give a few examples of the estimation of sugars by means of titanium trichloride, but these apply to the estimation of larger quantities and are different in detail, the general principle being much the same. The method would probably be very useful for the estimation of sugars on a larger scale, especially if a series of estimations had to be made.

few drops of blood should be available, as from the fingers for example, Bang's papers may be used. But however carefully these papers may be prepared we were never able to avoid occasional results considerably higher than the rest. As we have pointed out, these results appear to be due to reduction by constituents of the paper, and where the greatest accuracy is desired it is better to avoid the use of a paper altogether, as the paper has to remain for some time in the hot, slightly acid solution of potassium chloride. The papers can be avoided by using small brushes of glass-wool, as described below. The method, however, involves a filtration and is therefore less rapid than using Bang's papers.

The glass-wool brushes are easily made from pieces of fairly stout aluminium wire about fifteen centimetres long. A hook is made at one end, and a small coil of three or four turns at the other. A small bundle of glass-wool fibres is doubled up and placed in the coil. Both ends of the bundle are then cut even with scissors, the result resembling an ordinary small camel's-hair brush (*see* fig.)



The brush is then weighed on a torsion or other balance, touched against the drops of blood, and reweighed. Such a brush contains a large number of capillary spaces, and sucks up liquids very readily. Any amount of blood between 50 and 500 milligrammes can thus be collected and accurately weighed without coming into contact with any organic substance such as paper.

As soon as the brush with the blood has been weighed, it is moved up and down in a test-tube containing five cubic centimetres of the KCl solution. This will remove nearly all the blood from the brush. The liquid from the test-tube is then poured into a ten-cubic-centimetre centrifuge tube, and the brush and test-tube washed out again with five cubic centimetres of the KCl solution. The washings are poured into the centrifuge tube (if more convenient, the glass-wool may be pushed out of the wire coil into the tube), and the centrifuge tube heated in boiling water for half an

hour. The tube is then centrifuged for a minute or so, allowed to cool, and the contents filtered through an asbestos or small paper filter[1] directly into the heating flask. The centrifuge tube is then washed out with a further three cubic centimetres of KCl solution, which is then also filtered into the flask. The liquid should be quite clear after filtration.

If Bang's papers have been used instead of the glass-wool brushes, they are dried quickly and washed according to his method. Filtration is not generally necessary. Whichever of the methods has been employed, the filtrate will contain all the sugar from the blood sample, and will measure thirteen cubic centimetres.

If larger quantities of blood are available—two or three cubic centimetres for instance—it may be defibrinated and measured out in a calibrated Wright's pipette (Sir A. E. Wright, "Technique of the Teat and Capillary Glass Tube," pp. 26 *et seq.*). It is then pipetted into KCl solution, the liquid heated in boiling water for half an hour, as above, centrifuged, filtered, and the filter washed in the same manner as described above.

Method of Heating.—We have used small Erlenmeyer flasks, capacity about sixty cubic centimetres, for heating the filtrate with the Fehling's solution. A piece of stout rubber tubing is slipped over the neck of the flask, and projects about one inch beyond the top.

One cubic centimetre, measured from an accurate pipette, of the dilute Fehling's solution is added to the contents of each flask before the heating.

The flask is then rapidly heated in the naked flame of a Bunsen burner until it just begins to boil vigorously. This generally takes twenty-five seconds. It is then immediately placed on a small tray filled with coarsely powdered aluminium, and heated by a small flame. The boiling is continued for 2½ minutes, this duration of boiling having been found to give the most concordant results. The Bunsen flame and the small heating bath should be placed close together, so that the liquid is still boiling when the flask is placed on the heating tray.

After the liquid has boiled for 2½ minutes, the rubber-tube attached to the neck is quickly nipped tight by Spencer-Wells forceps, and the flask rapidly cooled in running water.

[1] The filtration through asbestos is apt to be slow, so that it is better to use a small quantitative filter paper. We have not found that such filters yield up any reducing or other substance to the liquid.

Method of Titration.—When the liquid is quite cold, the forceps are removed, and about four cubic centimetres of approximately N hydrochloric acid rapidly pipetted into the flask. Then a measured quantity (1·5 to 2 cubic centimetres, will be found sufficient with titanium trichloride of the usual commercial strength, made up as described above) of titanium trichloride is run in from the burette, about four cubic centimetres of a fifty per cent solution of ammonium thiocyanate added, and the liquid at once titrated with a very dilute ferric chloride solution, until a red tint is obtained which persists on shaking.

We have generally used a solution containing 1/400 of a gramme-atom of iron per litre = 0·1396 gramme Fe per litre. This may be most conveniently made up by dissolving 0·9805 gramme of pure ferrous ammonium sulphate in about 100 cubic centimetres of water, adding a slight excess of hydrogen peroxide and enough ammonia to render the solution alkaline, boiling for about ten minutes, adding twenty cubic centimetres of concentrated HCl, and making up to one litre. This solution will keep indefinitely.

From a large number of estimations made by this method, using pure glucose recrystallized from methyl alcohol, we have obtained as a mean value: One cubic centimetre of the above ferric solution = 0·107 milligram of glucose. Unlike Bang's method, this method does not require the passage of carbon dioxide of hydrogen into the flask during the titration. This is probably due to the addition of excess of acid to the contents of the flask immediately it is opened, the acid solution of cuprous salt apparently absorbing oxygen more slowly than the alkaline solution used in Bang's method. It is, however, necessary to conduct the operation as quickly as possible, as otherwise some oxidation may take place, and the results be too low.

Two or three blank estimations, using one cubic centimetre of the Fehling's solution with thirteen cubic centimetres of the KCl solution, heated in the manner described above, should be made with each series of blood-sugar estimations, and the mean amount of ferric chloride used in these subtracted from the amounts required in the actual estimations.

The difference multiplied by 0·107 gives the glucose found in milligrams.

If the Bang papers have been used to absorb the blood, two or three of the same papers without blood must be treated in an exactly similar way to those on which the blood has been taken, and the mean amount of ferric chloride used in these blank

experiments subtracted from the values obtained in the blood experiments. A good burette graduated in tenths of a cubic centimetre may be used for the ferric chloride. As the titanium trichloride solution is considerably stronger than the ferric chloride, and is added in excess of the amount required for the reduction of the coppper present, it is as well to make a preliminary blank experiment in order to find out the amount of trichloride required to give a suitable figure in the final titration with ferric chloride.

If too much titanium trichloride is used, a large amount of ferric chloride will be required in the final titration.

The titanium trichloride gradually decreases slightly in strength, but this can readily be compensated for by slightly increasing the amount added for each titration, should this be found necessary. Any titanium solution which has been standing for some time in the burette should be run out and replaced by a fresh quantity from the stock bottle before a series of estimations is made.

A brown colour or precipitate produced when the ammonium thiocyanate is added indicates that insufficient titanium trichloride has been used.

We have tested this method only for quantities of glucose between 0·05 and 0·25 milligram, as our object was to obtain accurate estimations of glucose in quantities of blood not exceeding two or three drops; but with suitable modifications, the method could doubtless be extended to the estimation of larger quantities of reducing sugar in blood or other fluids.

Examples of Results obtained.

Series 1.—Method of pipetting blood direct into KCl solution. Blood from ear of rabbit defibrinated. Blood measured out in Wright's throttled pipette, delivering 101 milligrams blood.

No. of experiment	Amount of blood used, in mgrms.	Amount of ferric chloride c.c.	Percentage of sugar in the blood
1	None. Blank experiment	4·02	—
2	None. Blank	3·97	—
3	101 mgrm.	5·36	0·144
4	,,	5·41	0·149
5	,,	5·39	0·147
6	,,	5·47	0·156
7	,,	5·45	0·154
8	,,	5·49	0·158
		Mean percentage of sugar in the blood	0·151

The method of calculation may be shown by reference to Experiment 3. In this case the mean amount of ferric chloride used in the blank experiments (4 cubic centimetres) is subtracted from

the amount used in Experiment 3 (5·36 cubic centimetres), the difference of 1·36 cubic centimetres being the amount of ferric chloride corresponding with the sugar in 101 milligrams of blood.

As previously mentioned, 1 cubic centimetre ferric chloride = 0·107 milligrams. Therefore, the percentage of sugar in the blood $= \frac{1{\cdot}36 \times 0{\cdot}107 \times 100}{101} = 0{\cdot}144$.

Series 2.—Blood pipetted direct into the KCl solution, exactly as in Series 1 (from the same rabbit after a fast for some hours).

No. of experiment	Blood used, in mgrms.	Ferric chloride c.c.	Percentage of sugar in blood
1	.. None. Blank experiment ..	5·63 ..	—
2	.. ,, ,, ..	5·69 ..	—
3	.. 101 mgrm. ..	6·84 ..	0·125
4	.. ,, ..	6·77 ..	0·118
5	.. ,, ..	6·76 ..	0·117
6	.. ,, ..	6·89 ..	0·130
7	.. ,, ..	6·87 ..	0·128
8	.. ,, ..	6·81 ..	0·121
		Mean percentage of sugar in the blood	0·123

Series 3.—Human blood taken up by glass-wool brushes from finger.

No. of experiment	Weight of blood in mgrms.	$FeCl_3$ c.c.	Percentage of sugar in blood
1	.. 174·5 ..	7·22 ..	0·106
2	.. 132·5 ..	6·71 ..	0·099
3	.. 97·5 ..	6·33 ..	0·092
4	.. 168·0 ..	7·03 ..	0·098
5	.. 107·0 ..	6·46 ..	0·097
		Mean percentage of sugar in the blood	0·098

Series 4.—Rabbit's blood defibrinated and pipetted on to Bang's paper with a Wright's throttled pipette. In this series the papers were also weighed before and after absorption of the blood, as a check on the delivery of the pipette which had been calibrated to deliver 101 milligrams of blood.

No. of experiment	Weight of blood, in mgrms.	$FeCl_3$ c.c.	Percentage of sugar found
1	.. None. Blank experiment ..	4·05 ..	—
2	.. ,, ,, ..	4·04 ..	—
3	.. ,, ,, ..	4·03 ..	—
4	.. 100·0 ..	5·16 ..	0·120
5	.. 101·5 ..	5·00 ..	0·102
6	.. 101·5 ..	5·03 ..	0·104
7	.. 101·0 ..	5·14 ..	0·116
8	.. 101·0 ..	5·27 ..	0·131
9	.. 102·0 ..	5·33 ..	0·135
10	.. 101·5 ..	5·20 ..	0·122
11	.. 100·5 ..	5·16 ..	0·120
		Mean percentage of sugar in the blood	0·119

Series 5.—Rabbit's blood defibrinated. Pipetted on to Bang's papers with Wright's throttled pipette, delivering 134 milligrams blood.

No. of experiment	Percentage of sugar found
1	0 138
2	0·132
3	0·135
4	0·132
5	0·121
6	0·135
7	0·126
8	0·138
Mean percentage of sugar in the blood	0·132

Series 6, 7, 8, and 9 below, are records of experiments, using Bang's iodine method instead of the titanium trichloride method.

Series 6 and 7 were made by Bang's method throughout, without any modifications.

In Series 8 Bang's method was used, except that asbestos was employed to absorb the blood instead of Bang's papers.

In Series 9 the "reversed" iodine titration, described on p. 695, was used.

Series 6.—Bang's original method, using papers to absorb the blood, and titrating with N/200 iodine.

Human blood from fingers.

B. Blood taken, in mgrms.	B. Percentage of sugar found	W. Blood taken, in mgrms.	W. Percentage of sugar found
113·5	0·134	109 0	0·126
109·0	0·123	93·0	0·151
119·0	0·137	107·0	0·114
93·0	0·137	119·0	0·106
125·0	0·121		
139·5	0·119		
Mean percentage of sugar in the blood	0·129		

The first set of determinations (B) gives a fairly concordant series of numbers.

Series 7.—Bang's original method. Papers used to absorb blood, and N/200 iodine for titration.

Rabbit bled from ear.

No. of experiment	Blood taken, in mgrms.	Percentage of sugar found
1	144	0·118
2	132	0·123
3	127	0·122
4	176	0·114
5	148	0·121
6	104	0·154
7	127	0·126
8	151	0·129
9	145	0·129
10	158	0·121
Mean percentage of sugar in the blood, including Experiment 6		0·126
Do. excluding Experiment 6		0·123

This is a concordant series except for No. 6, which is much higher than the rest, and again illustrates the abnormally high results sometimes obtained by the method.

Series 8.—Bang's original method, using N/200 iodine for titration. Modified by using asbestos instead of paper for the absorption of the blood.

Rabbit's blood defibrinated.

Blood taken, in mgrms.			Percentage of sugar found
118	..	..	0·087
117	..	..	0·096
119	..	..	0·103
119	..	..	0·099
118	..	..	0·099
119	..	..	0·111
118	..	..	0·112
119	..	..	0·090
	Mean percentage of sugar in the blood		0·100

Series 9.—Reversed Bang method (see p. 695). Titrated with N/200 thiosulphate. Rabbit's blood.

Blood taken, in mgrms.			Percentage of sugar found
120	..	..	0·106
,,	..	..	0·119
,,	..	..	0·119
,,	..	..	0·119
,,	..	..	0·119
,,	..	..	0·127
	Mean percentage of sugar in the blood		0·118

This series gave fairly concordant values, but a further series made in the same way gave discrepant values.

Blood taken, in mgrms.			Percentage of sugar found
120	..	..	0·097
,,	..	..	0·088
,,	..	..	0·092
,,	..	..	0·095
,,	..	..	0·153
,,	..	..	0·130

The two last values are considerably too high, and it is possible that this may have been due to some reducing substance derived from the absorption papers used.

EXAMINATION OF THE BACK.

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Back cases appear to be uninteresting to every one except those who suffer, or who have to pay. The idea seems to be that little or no *kudos* is to be got out of them in either the indoor or outdoor hospital departments, hence they are usually relegated to the care of the junior, and, therefore, the less experienced members of the hospital staff. As a matter of fact there is quite a fascinating interest in tracing an inadequately defined pain to its true source, or proving its non-existence.

The mechanism of the back is of such a nature that when thoroughly appreciated it enables a correct diagnosis to be made in the majority of cases; but this entails a careful study of the entire structure so that the parts unaffected may be eliminated in order that the true seat of the trouble shall be determined.

The somewhat haphazard method, which has hitherto largely prevailed, of grouping all injuries of the back into the category of "ricked" or "sprained" back, with no attempt at accurate or scientific diagnosis, has not unnaturally created an impression that when this is done it exhausts all the knowledge of the profession concerning injuries in this region. No other part of the body has been the subject of so much unskilled and random diagnosis, for the exact pathological condition present seldom seems to engage particular attention.

There is no doubt that "back cases" bristle with difficulties, and may be so complex as to lead to greatly divergent views, because the failure to observe one apparently unimportant factor may lead to an entirely wrong conclusion.

For a successful diagnosis, several things are essential. Firstly: One or more careful physical examinations, bearing in mind the conditions which may arise from natural causes, which are with difficulty distinguishable from those of traumatic origin; secondly, an appreciation of the psychology of pain; thirdly, a full history of the injury alleged.

One of the great difficulties in the examination of cases of alleged injury to the back is that with a large, stout individual, such as one often has to deal with, it is far from easy to make a

satisfactory examination of this part of the body, and one is tempted to accept the man's own statement (which under the circumstances is of little value) that he experiences pain at some particular spot.

It is not easy to discover what is amiss, even when there exists an actual physical cause for the pain complained of, but our worst difficulties commence when we come to determine whether the stiffness and pain alleged are real or feigned.

When disease exists in the spine Nature's warning is pain. When pain exists, stiffness and muscular rigidity naturally follow—similar to the well-known condition of the abdominal rigidity in appendicitis. It is reasonable, therefore, to believe that if there is no stiffness, and no rigidity, there is no pain and consequently no actual disease.

After middle life the spinal column gradually becomes less elastic, and in old age movements are always performed with difficulty, but not necessarily with pain.

Osteophytic arthritis is a common cause of limitation of movement of the spine in working men.

The small anatomical differences in the length of the lower limbs, which is much more common than is generally supposed, is, when it exists, compensated for by slight curvature of the spine. A lateral curve often gives a useful cue to an unsuspected asymmetry of the body.

When there is no complaint of pain on percussion over the spinous processes of the vertebræ it may be assumed that there is no gross damage to the neural arches.

None of the cervical spines (except the seventh) can, as a rule, be palpated. The spine of the seventh cervical vertebra is prominent, but it should not be forgotten that the first dorsal is often equally so. It is, therefore, unsafe in counting the spinous processes to assume that the prominence felt is the seventh cervical.

A line drawn horizontally round the body at a level with the highest point of the iliac crests covers the fourth lumbar spine. From this point the vertebræ may be counted upwards.

Where Fixidity Occurs.—In the normal state there is practically no widening of the spaces between the dorsal spines when the patient bends, and there is therefore no flexion in the dorsal region. Flexion of the spine takes place almost entirely at either the cervical or lumbar region, or at both. This is an important fact to remember when examining the back for injury.

Inability to move the cervical vertebræ is seldom fraudulently alleged, and the comparatively few cases which arise are easily dealt with.

The lumbar region, therefore, demands careful, and in the absence of alleged injury of the neck, exclusive attention in cases where it is stated there is inability to stoop.

A common experience in these cases is, that a claimant who alleges that months before he strained or injured his back, stoutly affirms that he is quite incapable of bending his back. When asked to do so he makes a slight forward inclination of his body from the hips and then resolutely declines to make any further attempt at movement. If he is simulating incapacity, the difficulty of proving it is great.

Obviously such incapacity is not associated with the cervical region; we have seen that the dorsal region does not contribute to the flexion of the spine, and therefore the alleged difficulty in stooping must, if it exists, be confined exclusively to the lumbar region. If this is remembered, it enormously simplifies the investigation of these cases, for the attention of the examiner may be wholly concentrated on the five lumbar vertebræ.

Tests for Fraudulent Stiffness of the Lumbar Vertebræ.—I am indebted for many of the following observations to Dr. A. McKendrick, from whose book on "Back Injuries" I have obtained much assistance.

Simulated fixidity of the lumbar region may be exposed by the following: The patient should be laid absolutely flat on his back, his heels, *knees*, buttocks and shoulders should touch the table. The natural forward lumbar curve is in this position apparent. It will at once disappear if the thighs are flexed on the abdomen, unless fixed by injury or disease.

If, whilst lying flat on the table in the position above described the patient is told to keep his knees straight and assume the sitting position, and then bend the upper part of his body a little forwards, the normal forward lumbar curve—if not fixed by injury or disease—will entirely disappear.

The patient is induced to sit in an upright position on a chair; if both knees are now extended, the normal forward lumbar curve disappears if not fixed by injury or disease.

The value of these three tests is great, for the positions which the patient has in each been induced to assume are, from an anatomical point of view, exactly the same which he declared was impossible when asked to perform them when standing! For it is

obvious that if, when lying on his back the patient's thighs are bent on the abdomen, the position is the same as if he had stooped so low *when standing*, that his head would approach the ground; and that if he can be induced to sit bolt upright, either on a table or on a chair, with his knees extended, he is in fact bending his body at a right angle to his thighs and would, were he standing, be making a very low bow.

There is, however, this difference, that in stooping forward in a standing position the body would fall, as it were, by its own weight, were it not restrained from doing so by the erector spinæ and other extensors of the back; whereas in assuming the sitting posture from the prone the body is raised against gravity and the flexors of the spine, i.e., the abdominal muscles, are brought into action. The fact, however, that a different set of muscles are brought into use does not diminish the value of the tests as far as capacity or incapacity to stoop is concerned.

Although these facts may be demonstrated to the satisfaction of the examiner, it is a matter of much importance in cases where arbitration proceedings are pending that indubitable *proof* should be forthcoming, and this, fortunately, can be procured. It is found in radiographing the lumbar region that when it is impossible to get a patient to move his lumbar region voluntarily, so as to come in contact with the X-ray plate, a better result is obtained if the knees are drawn up; this, as already stated, obliterates the normal forward convexity of this region and brings the vertebræ more in contact with the X-ray plate.

McKendrick points out that a permanent record of the fact that a patient who alleges he cannot stoop is, in fact, able to bend this portion of his spine, may be obtained by taking an X-ray photograph first in the position which the patient alleges is the fixed one, and second, with the knees drawn up. A permanent photographic record of the difference in size of the interlaminous spaces is thus obtained. When the lumbar vertebræ are in their natural position, i.e., curved forwards, the radiogram shows that the spinous processes approximate each other, whilst when the thighs are flexed on the abdomen they are widely separated. Comparative measurements taken between the shadows of the spinous processes in the two plates prove that movement *has* taken place. In radiography stout men are always a source of difficulty, but with "screen plates" I am informed it is usually possible to demonstrate that movement has taken place. These "screen plates" do not, of course, show the finer details necessary for demonstrating disease of the bones, but are sufficient for the purpose indicated.

Fracture dislocation is a serious injury. The nature of the accident and the condition of the patient immediately after its happening, are alone sufficient to prevent any likelihood of the condition being missed. Paraplegia would, of course, tell its own tale, and even the occurrence of girdle pains would be suggestive.

Fracture of a spinous or articular process, or one of the laminæ, is not likely to be missed if the case is seen early. The difficulty is that those who, like myself, examine for insurance companies, do not see these cases until long after the happening of the accident. These fractures, if recovery is to take place, are not long in uniting. When a patient gives a history of pain which has been constant over one spot, this, taken in conjunction with the nature of the accident, the subsequent history, and probably the presence of some amount of callus, lessens the difficulty of diagnosis. It is well to remember that simple fractures of the vertebræ are sometimes discovered by X-ray photographs when nothing was complained of but pain and stiffness. In doubtful cases, therefore, an X-ray examination should always be made.

In examining the spinal column it is not sufficient to place the hand on the patient's back, to ask the patient to bend forwards, and then to note that there is immobility, or what is called "boarding" in a certain region. This, McKendrick points out, is only half the truth, and recommends that the examiner's hand should be kept for at least a full minute on the patient's back, which should be bent as far as possible. The back may remain absolutely stiff from disease or traumatism, or, on the other hand, the muscles beneath the examiner's hand may begin to twitch, followed by a "giving" of the spine. At first the relaxation or "give" is very short and this is followed by a slightly longer one, and so on until the spine is fully bent, indicating that the erector spinæ has been voluntarily kept in action. The muscle, the erector spinæ, which produced the "boarding," has gradually become tired out and finally exhausted. This condition, he states, is often found in malingering and in hysteria, but never in traumatic neurasthenia. On the other hand, when the rigidity has been due to either rheumatism or strain of the spinal joints the "give" is more or less gradual, each becoming shorter than its predecessor until the back is fully bent.

If a man really has pain in the cervical or upper dorsal region it can generally be elicited by bending the head forward, whilst the trunk is held rigid, thus stretching the vertebral muscles; if this can be done without producing pain, the probabilities are that the pain alleged is not due to physical causes.

When the back is bent, each separate vertebra in the cervical and lumbar region moves a little upon its fellow, and each spinous process is separated a very short distance from those of the neighbouring vertebræ. If, therefore, when a patient stoops, the fingers of the examiner's two hands are pressed between the spinous processes first of the cervical and then of the lumbar regions, and the patient is asked slowly to raise himself to the erect position, and the spinous processes are found to separate upon flexion of the spine and approach each other as the spine is straightened, and this without pain, it goes a long way towards proving that there is no disease at the particular spot examined.

In cases where the only complaint is of subjective symptoms it is seldom that one examination is sufficient to enable a definite conclusion to be arrived at; and the examination should be repeated, if practicable, as many times as are necessary to enable a correct opinion to be formed.

The power of rotation of the cervical vertebræ can be elicited by asking the patient, when standing with his back directed to the examiner and his feet placed closely together, whether since the accident he has had any trouble with his hearing. The auricles are alternately taken between the finger and thumb, and the head gently pulled well to one side, and then the other, under the pretence of getting a good light into the meatus. This little manœuvre rotates the whole spine and has the advantage of being easily demonstrated to the applicant's doctor if this is thought desirable.

It is curious to note how often one who wishes to allege spinal injury complains of pain at the tips of one or more of the spinous processes of the vertebræ. The places indicated should first be marked, counted, and carefully noted, and the results compared at intervals, both at the examination and at subsequent interviews. The use of different coloured chalks is of assistance in making these records.

There are many apparently innocent means by which a man may be induced to bend his back directly he enters the room and before the formal examination has commenced. I have repeatedly ascertained the flexibility of a spine before the patient knew it was being tested.

As a rule, working men bring their cap or hat into the room when they come to be examined. In a casual way he is instructed to put it *below* the chair on which he is offered a seat. It never strikes a working man that this is in any way an unusual

proceeding. Indeed, he seems to think it the correct place for his hat. Under the assumption that the examination has not yet commenced he often forgets himself, and when he stoops I casually remark, often in a low tone, speaking, as it were to myself, "Cannot be much the matter with his back *now*, any way, judging from the way he can bend." It is astonishing the large number of cases in which the whole question of further examination, diagnosis, treatment, and alleged continuing disability, is finally settled by such a proceeding, and an explanation follows that, whereas the back has been "bad," it has now recovered, a line of least resistance in which I willingly acquiesce, and sometimes even suggest. It has always struck me that it is a waste of time and bad policy to thoroughly examine a claimant who admits that he has recovered, and I commend this little manœuvre as a time and labour-saving expedient.

This remark does not, of course, apply to cases sent for medico-legal examination, but only to those where an opinion is sought, by large employers of labour, as to the continuing disability of their employees.

There are occasions when one is quite convinced that there is absolutely nothing the matter with a man, but the positive proof required to demonstrate the fact is lacking. In such cases, if one is in a position of authority, a good result may sometimes be obtained from a frank avowal of the position and the offer of a bargain. Let the man know your difficulty, tell him candidly you have not for the moment the requisite proof in your possession to report him as a malingerer, hint that in the event of his speedy recovery the case will be treated as a recovery, and that no adverse report will in that case be made. He should be given to understand, however, that the alternative implies, of necessity, a renewed effort on your part, and the inexorable exercise of your powers when successful, and that this is only a matter of time. My experience is that this offer is often readily accepted and a graceless retreat is made from a position which it is appreciated is really untenable. The plan has the obvious advantage that the real sufferer is at no disadvantage, for should the case be a genuine one, continued investigation would demonstrate the truth of his allegations.

The almost transparent device of accidentally dropping a pencil in the hope that the patient will unconsciously pick it up, or the more artful method of surreptitiously dropping a coin or small article of the patient's clothing on the floor, often shows the functional activity of the extensors of the spine in a way which more scientific methods fail to elicit.

The trap, however, into which the most hardened malingerer will sometimes fall is (his trousers and pants having been during the examination dropped to his ankles) to indicate in a tone of relief and finality that the examination is at last concluded. The examiner should at this moment turn his back on the patient; if a mirror should happen to reflect the movements of the patient much satisfaction will often be caused by seeing the man stooping to reach his clothes with an agility which no amount of coaxing had previously produced.

Simple ruses such as these will often succeed, though their chances are becoming more and more remote, as applicants are now too often coached in the parts they have to play.

A patient who is alleging pain at a definite spot in his back, which does not exist, may be detected by the simple expedient of asking him to place the point of the forefinger of his right hand on the spot, and marking it, and subsequently after another part of the examination has been undertaken, asking him again to indicate the spot, but this time with the point of the forefinger of the *other* hand. The result is often edifying, because he may point to a spot several inches away from the first one. When the area affected by the pain has been indicated, with more or less exactitude, complaint will probably be made of the lightest touch in that region; it is therefore necessary to resort to various devices for withdrawing the attention from the locality presumed to be affected.

It is seldom that the spine is forcibly bent forwards, but such an accident might follow a severe weight suddenly falling on the shoulders. In this case the posterior common ligament, the supra-spinous ligament, or the ligamenta subflava may be torn.

When an injured muscle is actively put into contraction, *or* when it is stretched, pain is produced. If the erector spinæ is injured and the patient actively tries to *straighten* the back, or if the spine is flexed, thus stretching the injured muscle, pain will be complained of.

The man who complains of severe pain in the erector spinæ or its prolongations, and keeps his back bent many months after an injury lays himself open to grave suspicion.

When patients allege a tear in the neighbourhood of the erector spinæ, instead of complaining as so many do when the back is straightened they ought to be grateful, for if any of the fibres of this muscle are really injured the effect will be to relax the fibres.

Sometimes the following experiment is of use. The man who declines to assume the erect position may be induced to do so

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unwittingly, by being asked to kneel on the floor and rest his elbows upon his folded clothes, in such a position that his back is straight.

A good deal may be gained from a careful consideration of which muscles are used for the purpose of bending the spine. It must never be forgotten that the muscles which produce lateral movement are exactly the same muscles as those which produce extension, and therefore, if a claimant says he cannot straighten his back, but is able to touch the ground first on one side and then on the other, it is obvious that the disability, if genuine, is not in the erector group of muscles of the back. On the other hand, if he persistently complains that he cannot straighten his back, and in addition that he cannot bend it, let us say to the left side, whilst he admits that bending it to the opposite side is *painless*, the presumption is that one of the erector group on the left side is in fact strained or in some way injured.

Working men are, of course, unaware of the anatomy and action of the muscles involved, and I have seen a malingerer pretend, a year after the happening of a slight accident, that his back muscles were so painful that not only could he not straighten them, but any attempt to passively extend the spine produced the most intense pain. The whole back was bent forwards, but it was evident that the spinal column was bent forwards from the hip joints, and this was demonstrated by putting the hand on the lower part of his abdomen and at the same time attempting forcibly to straighten the back, when the powerful abdominal muscles which are the flexors of the spine were found to be in violent contraction.

In old-standing cases, if a patient complains of pain when an attempt is made by the surgeon to extend the spine, the injury, if any injury there be, is in the flexors of the spine, i.e., psoas, rectus abdominis, external oblique, internal oblique, transversalis, or the anterior common ligament.

> On one occasion a malingerer who had kept his back persistently flexed from the lumbar region for many months, when lying on his face on the examination couch, permitted the pillow to be gradually raised. The position not only straightened his back, but actually curved it in the opposite direction without any complaint of pain either in the flexors, extensors, or in the spinal column itself!

Torn Muscles.—In cases of accident, the most usual injury is a tearing of the fibres of some of the lumbo-sacral muscles, or a

sprain of one of the numerous vertebral joints, or of the sacro-lumbar joint. It is, however, ridiculous for anyone to allege, as I have known done, that a sudden wrench tore a muscle or produced a sprain in the back, the pain of which only manifested itself after an interval of some hours. Anyone who has torn a few fasciculi of one of his own muscles will have no sort of doubt about this. On two occasions patients who suddenly ruptured a few fasciculi of the gastrocnemius have told me that they were confident that someone had thrown a stone from a distance and suddenly struck them on the calf of the leg, and that they were wholly incapacitated then and there. If a rupture of a muscle is recent there are certain conditions which must inevitably accompany it; sudden pain, a gap at the seat of rupture (especially when the muscle is put on the stretch), a hæmatoma with consequent swelling, pain, tenderness, and loss of function. The pain is likely to last, if at all severe, several weeks.

A torn muscle of the back produces a considerable amount of swelling and effusion. The injury may involve other structures, such as ligaments or nerves, and the patient suffers severely. At this stage, no dispute as to the condition ever arises, for employers and Insurance Companies seldom suggest simulation at the acute stage of a disability following an accident, and as a rule it is only many months afterwards when the condition may be termed more or less chronic, and when the difficulty is greater, that the medico-legal expert is called upon to make a diagnosis.

It should be borne in mind that a muscular tear or rupture is invariably single, and therefore *unilateral.* A strain is merely a stretching of tissue beyond its physiological limit. The lumbar fascia has this in common with all muscles and ligaments, viz., that there is a point which can be definitely located where a tear or strain has taken place, that is, there is always a point of maximum tenderness or pain. Notwithstanding the fact that the belly is the point at which there is the greatest tension when a muscle is brought into action, yet the mechanically weak spot is where muscular joins fibrous tissue.

The latissimus dorsi is the chief muscle used in giving a downward blow or thrust. When this muscle is injured, pain is produced on moving the arm, or in drawing it backwards. Backward movement of the shoulder is also painful.

It is possible that a sudden strain may tear some of the slips of origin from the vertebral column of the trapezius or latissimus dorsi.

Mr. Morley has pointed out in his paper on "Injuries to the Back in their Medico-Legal Aspect" (*XVIIth Internat. Cong. Med. Trans., Section of Forensic Medicine*) that, when muscles other than those of the back are torn, the correct surgical treatment—that of fixing the limb in a position of relaxation of the muscle—is always followed. But these surgical principles are seldom, if ever, applied to torn muscles of the back. The usual treatment for a patient with a torn erector spinæ is to put him on his back with pillows under his head and shoulders. This, by flexing the back, puts the injured muscle on the stretch, leaves it in the worst possible position for repair, increases the tendency to hæmorrhage at the seat of rupture, delays absorption, and renders massage impossible. The prone position with sandbags under the shoulders and pelvis is obviously the correct physiological position for injuries of the muscles of the back, and, as he points out, this position admits of the employment of massage *from the very beginning*, without undue disturbance of the patient, for it is as unjustifiable to keep an injured muscle of the back fixed without treatment as it obviously is to keep a sprained ankle or a fracture immobilized.

The following is an almost daily experience with those who see much of medico-legal work :—

> A working man falls whilst at work, injures his back, or it may be he sprains it whilst lifting a weight. The pain at once compels him to keep his back in a stiffened position. He consults a doctor, who enjoins the most complete and absolute rest, and perhaps prescribes the recumbent position in bed. Now, it is obvious that during the first few days, when the exudation in the fibrous tissue is being poured out, rest is essential, but, if massage and movement are not soon systematically and daily performed, the absorption of the exudation will not be encouraged. The longer the rest, the greater will be the subsequent pain and the difficulty in resolving it.
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> The difficulty, as already explained, is that movement and massage, even after the acute stage, at first, but only for a short time, increases the pain. Unless, therefore, the patient has great confidence in his medical adviser and the masseur, has some pluck and a really genuine desire to be cured, this method of treatment fails because it cannot be properly carried out. The principle involved is really well-known, and is, indeed, carried out daily in the modern method of treatment of a sprain of the ankle-joint. Everyone now knows that, apart from the rest necessary during the first few days, the earlier natural movements are resorted to the shorter will be the duration of the disabling effects. Yet one finds strong, healthy, able-bodied men who have had a strain of the muscles

of the back keeping their back rigid for weeks, months, and sometimes even for years, for no other reason than that the steps above indicated have not been taken. They could be rapidly cured by active, vigorous and intelligent treatment.

Shufflebotham has for a long time advocated the employment of systematic exercises, and, where there is much wasting, electrical stimulation. Passive movements and early massage promote absorption of effused blood, relieve pain immediately, improve nutrition, and certainly effectively prevent adhesions. The patient after a little time should be encouraged to perform gradually increasing movements, and later the use of light dumb-bells, exercises, such as touching the toes, extending the shoulders, etc., should be practised.

The late Mr. Edmund Owen suggested that to paint tubercular glands with iodine is as likely to be successful as would be an attempt to please the Dean of St. Paul's by stroking the dome of that edifice; and I think to keep a patient who has injured one of his back muscles in bed for a lengthened period in a semi-flexed position, to apply porous or "poor man's" plasters, is likely to be equally unsuccessful.

It must never be forgotten, in dealing with pain in the back after an alleged accident, that long after the physical phenomena have disappeared, the psychic effects of unintelligent treatment, misplaced sympathy, and sick pay, often leave their effects of a perverted mental outlook and a morbid introspection which can only be eradicated by isolation from sympathising friends and the usual concomitants preparatory to legal proceedings. Treatment in a hospital is undoubtedly the best means of bringing this about.

The actual tissue inflamed in lumbago is the fibrous tissue surrounding the fusiform nerve end organs which lie between the muscle fibres. This explains the severity of the pain and its close relation to movement.

Lumbago is not accompanied by a rise in temperature, and no clinical examination can, after the first few days, distinguish between lumbago and injury, unless there is external evidence, such as bruising. Unfortunately, many of the cases of alleged pain in the back where the question of compensation has arisen, are seen many weeks, or it may be months, after the accident, by those who are called upon to examine them at the instance of employers or insurance companies.

In the fibrositis (lumbago) which follows a sprain, it is always extremely painful for the patient to rise from the stooping position

by his own exertion, whilst if the movement is performed passively, through the intervention of another, it is much less painful. *At the onset*, there is no maximum point of tenderness, but after a few days, if the condition persists, the pain is localized, and indeed, there is, as time passes, frequently a spot that is very tender on pressure. This is almost invariably so after two or three weeks.

In the *very early* stages of a ruptured muscle there is a *maximum point of pain.*

The persistence of pain in muscles and in the neighbourhood of joints long after the happening of an accident, often makes prognosis difficult.

Rheumatism is often spoken of as "chronic." True rheumatic fever runs a definite course and never becomes chronic. Certainly it has such sequelæ as a leaking valve of the heart, or chronic pain in the fascia or the aponeurosis of a limb, generally in the neighbourhood of a joint, but acute rheumatism cannot become chronic. What the acute rheumatic fever has left is a thickening of the white fibrous tissue either of the valves or other structures.

When a joint is said to be rheumatic it is not the cartilage or the bone which is affected with rheumatism, but the fascia, and more often the fibrous insertions and aponeurosis, of surrounding muscles.

The essential pathology of this variety of rheumatism consists in an inflammatory overgrowth of the white fibrous tissue which enters so largely into the composition of muscle. This overgrowth or hyperplasia, is probably brought about by the action of toxins conveyed by the blood, and multiplication of the white fibrous tissue cells is produced, which is followed by serous exudation. Hence it is that tendons and sheaths of muscles, and the fibrous and ligamentous structures of the joints become affected, and produce what is so often called "chronic rheumatism." These exudations if fairly large, can be felt, more especially at such places as over the sternum or tibia, or other thinly covered bones, and are tender and painful on pressure.

If *early* treatment is resorted to they may be made to resolve readily enough, but the older and more fibrous they become the greater the difficulty in treatment, and the less likelihood of cure.

The actual form of these hardened swellings, or nodules, as they are called, varies; the most common form is a definite, circumscribed, hardened spot the size of a split pea or a small shot, but they may be as large as an almond, or even half the size of a walnut. Often they are rounded or flattened and may sometimes

be felt like a beaded chain along the fibrous edge of a muscle or aponeurosis.

In the lumbar region, or in the fascia lata, large portions of subcutaneous fibrous tissue, or of an aponeurosis, may become uniformly thickened and form a more or less prominent induration at certain parts. Sometimes these thickenings are deep, sometimes superficial. Occasionally those on the surface pucker the skin. When pressed upon they are always tender, and if vigorously rubbed they swell and become temporarily more painful.

When the white fibrous tissue becomes inflamed and proliferates, the condition is known as "fibrositis." As a result of the strain of a tendon or ligament a local fibrositis is often brought about, which may persist for weeks; for instance, the fibrous tissue of the muscles of the arms and back are sometimes the subject of a local fibrositis, the result of a sudden strain whilst playing tennis or golf. A stiff neck and lumbago are milder forms of the same condition.

Lumbago is, in fact, a very typical form of fibrositis, the milder type being confined to the fibrous elements in the lumbar muscles. A severe type, however, is that which starts as a localized affection of the insertions of the great erector muscles of the back at their fibrous attachments to the sacrum and neighbourhood of the sacro-iliac joints. This, as is well known, sometimes even finds its way to the sheath of the great sciatic nerve, producing the sciatica which so often follows lumbago.

In conducting the search for these nodules it is necessary to smear the skin with oil or vaseline and to see that all muscles are relaxed. If the thumb or tips of the fingers are then passed over the skin with firm but gentle pressure, the nodules or indurations can sometimes be readily felt, but they are not always easy to locate, even on deep pressure, which is often required. The most frequent sites are the lumbar aponeurosis, the fascia lata, and tendinous expansions of the thigh muscles, the trapezius muscle just above the supra-spinous region, and the soles of the feet.

Weakness of the back and symptoms of what is sometimes called "spinal irritation" are often due to nothing more serious than these fibrous indurations. I believe that the persistence of fibrositis in this region is a common cause of the refusal to work sustained for long periods—sometimes extending to years—by working men who have had accidents.

Many women who are considered hopeless neurasthenics or martyrs to neuralgia, and who, on account of continuous aches and pains, gradually develop ill-health, have these fibrous thickenings to thank for their condition.

The condition is familiar, and, indeed, is often seen in an ordinary sprain or rupture of a muscle where the fibrous hyperplasia gives rise to what are called "rheumatic" symptoms, which vary from time to time and under different conditions, such as cold, damp, meteorological changes, muscular exertion, or even an acute attack of indigestion. The swellings probably exert pressure on the filaments of the sensory nerves; hence the pain. Hard nodules, if they involve a nerve, sometimes cause aching and shooting pain over a wide area.

Treatment.—Now that the pathology of this troublesome affection is understood, and the old theory of a uric-acid diathesis and what not exploded, we may reasonably hope for good results from a rational and scientific method of treatment.

General massage is unnecessary. The massage movements should be confined directly to the painful parts, that is, where there are nodules and indurations. As a rule, it is best to shave the skin and smear it with some oleaginous substance before beginning the treatment. The massage should be gentle for a few days, and gradually made more and more vigorous day by day. In a few days the fibrous thickenings swell up and become both more obvious and painful. It is at this state that it requires some fortitude to withstand the temptation to give up all treatment, because the inconvenience may last for ten days or even longer. The nodules immediately beneath the skin are particularly liable to become tender, and the treatment has to be carried out very judiciously, until the patient appreciates the undoubted benefit which is to follow.

At the acute stage, therefore, only very gentle manipulations are called for in order to promote the removal of exudation, and Luff holds that even this should not be employed where it causes pain *at the acute stage*. However, after this stage has been passed, there is no question that very vigorous, even painful, massage, pressure, and friction are eminently successful in removing the tension of the tissues, and therefore the stiffness. It undoubtedly in time makes the swollen fibrous nodules disappear.

Stockman, to whose writings on this subject I am much indebted, writes:—

> "After a time they (the nodules) begin to shrink in size and become more fibrous and callous; much more pressure can then be exerted on them, the fist or knuckles being used, and in process of time they become quite small and hard, and ultimately disappear entirely. The massage should be carried out daily, ten or fifteen

minutes or more being devoted to each region affected; at the beginning and end about two minutes of gentle effleurage should be given, as it soothes the part and removes serous engorgement."

Muscular movement relieves the tension and temporarily relieves the pain, and although at first this returns, after a few hours, daily repetitions of more and more vigorous muscular movement, combined with massage, have their effect.

The difficulty in the treatment is to get the patient to submit to massage and to movements which are painful, and the less intelligent the subject, the greater the difficulty. Septic absorption from pyorrhœa alveolaris is well known to be a fruitful source of fibrositis, and, as already pointed out, when present at the occurrence of an accident frequently retards recovery.

ON SOME CASES OF ABDOMINAL INJURY TREATED AT THE FRONT.

By Captain E. H. UDALL.
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in conjunction with
Captain W. C. HORTON.
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THE main part of this article will consist of abstracts from the notes kept on the cases, but a few explanatory remarks may prove interesting. The cases referred to are all cases which passed through —— Casualty Clearing Station on the Cape H. end of the G. Peninsula between the dates of May 31 and August 31, 1915, both dates inclusive. No notes of the cases previous to this are available, and my last day on duty with the unit coincides with the latter date.

On account of the desirability of dieting and retaining cases of abdominal injury a special "ward" was opened for the admission of cases of suspected or possible abdominal injury, and the care of this ward was handed over to me in May. Throughout the work of the department was done in close consultation with Captain Horton, who on more than one occasion took charge of it during my forced absence.

Our firm conviction at this time was that the best routine treatment for such cases, in the circumstances in which we were placed, was absolute rest and starvation for forty-eight hours, morphia being ordered in cases where the patient was restless or where internal hæmorrhage was thought to be present. The patient was therefore left on the stretcher on which he was brought in unless dirt or blood necessitated a clean stretcher, and if he was at all bad his clothes were not removed for fear of disturbing him. He was allowed to gargle, but not to swallow anything.

It soon became apparent that cases so treated did badly, and it was decided to treat cases in the semi-recumbent position where the symptoms of shock and hæmorrhage permitted of this. About the same time the question of operation was seriously considered. In deciding on this point there were several general conditions and considerations to be dealt with.

(1) The station was encamped on very dusty ground where

dust storms were the rule and lasted for hours at a time. This dust was potentially full of infection, with a grave risk of tetanus, owing to the proximity of horse lines, latrines, etc., the military necessities being such that it was impossible to encamp at a proper distance from such sources of infection. The "theatre" consisted of the regulation operating tent, which was found to be almost useless as a defence against dust.

(2) Flies: These were very numerous, and when operating by day it was impossible to keep them from crawling over towels, dressings and instruments. These were mainly house and stable flies. When operating at night the flies would fall in scores from the light on to wound, towels, etc. These were mainly a species of mosquito.

(3) To begin with we had no beds, and the difficulties of post-operative nursing on a stretcher were very considerable, especially as the stress of work in other departments of the clearing station made it very difficult to ensure the constant presence of an adequate staff of sufficiently trained and experienced orderlies. During the time covered by this article we lost at least two orderlies killed by shell fire and one sent away on account of sickness, whom one had partially trained, and who had gained some degree of experience in dealing with this class of case.

In view of these and other minor considerations, it was decided that any operative interference should be as rapid and as simple as possible, and it was resolved to try the effect of simple drainage in cases which did not progress satisfactorily under the original treatment and which seemed fit to stand such a slight operation. The procedure usually adopted was to make a small incision between the umbilicus and pubes and insert a large rubber drainage tube into the pelvis, no attempt being made to deal with hæmorrhage or perforation unless some obvious trouble presented itself which could be rapidly dealt with at the time of operation. As shown by the notes of the cases later, the actual procedure differed slightly in different cases, but the above was the underlying principle. In almost all cases operated on the operation was performed by Captain Horton.

Admission.—The cases were brought to the station on motor or horse-drawn vehicles over extremely rough roads, the time between the reception of the injury and admission varying widely. In at least one case the patient appears to have been lying out for forty-eight hours before he could be attended to by stretcher-bearers. Others were detained for twenty-four to forty-eight hours by a field ambulance before being transferred, and others were received direct from the firing line within a few hours of being wounded.

Discharge.—The main principle aimed at was to retain all cases of possible intraperitoneal or visceral lesion for a minimum of forty-eight hours after the reception of the injury, after which time the cases were evacuated to a hospital ship as expeditiously as possible if the general condition of the patient warranted removal and the conditions were suitable. The main condition requiring consideration was the state of the sea, as cases had to be conveyed to the hospital ship, which usually lay about a mile from the shore, in a naval launch, and consequently no seriously bad case could be transferred when the sea was at all rough. In at least one case, No. 258, death appears to have been directly due to too early removal. Some cases were evacuated earlier than would otherwise have been the case on account of shell fire or in order to take advantage of an exceptionally calm sea.

A further modification of the original routine in treatment, suggested by an official pamphlet, was the early administration of small quantities of water by mouth. This treatment was started about No. 200 in the series, all cases, except those in which gastric perforation was suspected, being given half an ounce of boiled water every hour. In no case did this treatment appear to do any harm, and the comfort and general condition of the patients showed a noticeable improvement on that of those previously treated by absolute starvation.

In all cases saline was given either hypodermically or intravenously when its use was indicated, as far as the circumstances allowed, but when it is stated that twenty-four cases were admitted to the department during the first four days of June, and that during this rush, as during others, all other departments of the clearing station were equally rushed, it will be understood that it was unfortunately unavoidable that many cases were unable to receive the amount of individual attention which one would have wished them to have.

Two hundred and sixty-seven cases were admitted to the abdominal ward. Of these, ninety, i.e., 33·71 per cent, died.

Of the 267 cases, in eighty-eight cases the records are too scanty to admit of definite conclusions as to the presence of intraperitoneal or visceral trouble.

Of these eighty-eight cases, thirty-six, i.e., 40·90 per cent, died in the clearing station, the remainder being either evacuated further along the line or kept until fit for light duty. None of these eighty-eight cases was operated on in the station.

Of these thirty-six deaths a large number occurred on the day of admission, a fact which suggests that they arrived in too collapsed

a condition to have gained much material benefit from surgical interference, even had this been possible. Some of the cases were moribund on admission, and some were almost certainly chest wounds and died of chest trouble.

Of the 179 cases, of which fuller records are available, fifty-four, i.e., 30·17 per cent, died.

Of these 179 cases, seventy-five showed either definite signs of peritoneal or visceral trouble, or signs suggestive of the possible presence of such trouble.

In twenty-three out of these seventy-five cases surgical interference was made, and of these twenty-three cases fourteen died, i.e., 60·87 per cent.

Of the forty-eight unoperated cases thirty-five died, i.e., 72·92 per cent.

Four cases operated on before admission to the clearing station are included in the seventy-five positive cases, but as the operation was not performed in the clearing station, and the cases were merely passed through on their way to the hospital ship, these four cases are not shown in the following tables.

Table I deals with the forty-eight unoperated cases.

Table II deals with the twenty-three cases operated on in the station.

Table III deals with the three cases operated on, but showing at operation no peritoneal or visceral lesion.

Of the cases included in Table III it will be noted that in two cases abdominal rigidity and tenderness, and impaired mobility, were present, in both cases the wounds being situate far back.

Cases 20 and 40 in Table I would also seem to come into line with these cases, as also several others in the series which are not included in these tables, having been ruled out as spinal cases.

The difficulty of making an accurate differential diagnosis in these cases is often, in our experience, considerable. Of course, in some cases with paralysis of the bladder, the pain, rigidity, and distension may be removed by catheterization and the diagnosis cleared up in this way, but there still remains a certain number of cases of wounds situate in the neighbourhood of the spine in which the missile may or may not have entered the abdomen, and which after catheterization still show some degree of abdominal tenderness and rigidity with impaired mobility, along with more or less definite signs of spinal injury such as some degree of paralysis in the lower limbs.

In only one case—No. 82 of the series, No. 23 of Table I—

was a post-mortem examination made. This is greatly to be regretted, but the stress of work made it difficult at times to find time to make such an examination, and the flies made the performance of it almost an impossibility.

TABLE I.

FORTY-EIGHT UNOPERATED CASES.

Number	Number in series	Nature of injury	Result
1	1	Bullet entrance twelfth rib right side below angle of scapula; exit left mid-axillary line below nipple. Entrance also left arm, region of biceps, bullet still in arm. No apparent injury to bone or vessels. Collapsed, pale, cold, and restless on admission 9 hours after reception of injury	Died 17 hours after reception of injury.
2	3	Wound almost in mid-line about half-way between umbilicus and symphysis. Slight rigidity on admission on day following injury, but general condition fairly good	Became suddenly worse and died about 45½ hours after reception of injury.
3	6	Multiple wounds: Left arm, forearm, and thigh. Right leg. Left nipple line just below umbilicus. Immediately above right nipple. Left posterior axillary fold just below nipple level. Right posterior axillary fold just below nipple level. Tenth rib below angle of right scapula. (?) Slight intraperitoneal trouble as suggested by pain in R.I.F. on second, and slight abdominal tenderness and rigidity on third day after reception of injury; clearing up on fourth day	Discharged on fourth day after reception of injury. Probably no intra-peritoneal lesion.
4	11	Wound about eighth costo-chondral junction. Rapid, weak, uncountable pulse on admission 6½ hours after reception of injury. Respiration 52, catchy and irregular. Abdomen slightly distended, tender, dull in both flanks; considered to be intra-pleural and intra-peritoneal injury with hæmorrhage	Died 17½ hours after reception of injury.
5	12	Entrance right flank; exit (stitched before arrival) 2 inches below angle of left scapula. Respiration 36, pulse rapid, weak, and uncountable on admission 4½ hours after reception of injury. Next morning, pulse rapid and thready, patient restless. Abdomen rigid and tender, especially on right side	Died 56½ hours after reception of injury.
6	35	Wounds: Internal to ninth costal cartilage, left side, and behind posterior axillary line, left side about same level. Also right elbow, thigh and leg. Pale, pulse 104, very weak. Abdomen soft, but moving poorly on admission. Vomiting first night. Next day pulse 120, very weak. Abdomen rigid and tender in right flank	Died 48 hours after reception of injury.
7	39	Bullet entrance L.C.M., just behind N.L.; exit, just below L.C.M. in N.L. To all appearance a superficial wound only, but included on account of the development of abdominal tenderness and rigidity, followed on third day by vomiting and distension. Relieved, but not entirely cured, by olive oil enema	Discharged on fourth day after reception of injury.

TABLE I—*continued.*

Number	Number in series	Nature of injury	Result
8	41	Entrance, epigastric notch to left of mid-line; exit just below C.M. in right posterior axillary line. Slight abdominal rigidity; pulse 100, on admission 3½ hours after reception of injury. Next morning, pulse 120, but abdominal symptoms less. In evening, bilious, bloody discharge from exit wound. Pulse weak. General condition worse	Died 42½ hours after reception of injury.
9	45	Entrance about tip of ninth L.C.C.; exit about ninth rib in right axillary line. Face cyanosed; pulse weak and rapid; abdomen rigid and tender; right flank dull; yellowish-brown bloody discharge from exit wound; subcutaneous emphysema left side on admission 2 hours after reception of injury	Died 18½ hours after reception of injury.
10	47	Entrance right buttock; exit 3 inches above symphysis and immediately to left of mid-line. Wound also left leg. On admission, very restless and collapsed, pulse 146. Abdominal rigidity noted the following day	Died 26½ hours after admission. No record of time of reception of injury.
11	49	Entrance just to right of spine about seventh thoracic level; exit 2 inches below and just internal to right nipple. Pale and collapsed on admission 3½ hours after reception of injury. Developed some abdominal tenderness and rigidity and marked emphysema of chest wall. Also hæmoptysis and apparent hæmatemesis, probably swallowed blood	Died 27 hours after reception of injury. Death considered to be mainly due to thoracic condition.
12	50	Entrance left loin; bullet palpable 1½ inches above umbilicus. Restless on admission 3 hours after reception of injury. Developed rigidity, tenderness, epigastric distension and obliteration of L.D.	Died 43 to 44 hours after reception of injury.
13	51	Bullet entrance, eighth rib in left axilla; no exit. Wound also left arm. Track of chest bullet, forwards and inwards. Much external hæmorrhage necessitating firm packing. No definite abdominal signs observed, but case is included as one in which abdomen was probably implicated on account of track of bullet	Died about 24 hours after reception of injury.
14	53	Wounds: Just above and to outside of right nipple; epigastrium to left of mid-line. Abdominal rigidity, but no tenderness, on admission 2 hours after reception of injury. Next morning pulse very weak, uncountable at wrist; has been vomiting (? blood). Abdomen rigid and tender	Died about 38½ hours after reception of injury.
15	57	Entrance left buttock behind posterior axillary line. Bullet under skin 3 inches to left of umbilicus. Wound also left thigh. Complained of flatulence; abdomen rigid, tender and motionless on admission about 6½ hours after reception of injury. Abdomen became softer and flatulence less. On second day after reception of injury—vomiting, which became fæcal, and hiccough. Vomiting cleared up next day, but hiccough continued and was still present on discharge, though abdomen was soft and mobile, and general condition was fairly satisfactory	Discharged about 88 hours, or more, after reception of injury.

TABLE I—*continued.*

Number	Number in series	Nature of injury	Result
16	58	Wound left buttock; no exit. On admission 3 hours after reception of injury, was thought to be probably only an extra-abdominal wound. Next day: Restless, pulse uncountable, hæmaturia, abdominal rigidity with epigastric retraction on inspiration, and diffuse tenderness	Died on day following reception of injury.
17	59	Entrance behind left shoulder: no exit. Some hæmoptysis before admission 2 hours after reception of injury. On admission, slight abdominal rigidity and epigastric and supra-pubic tenderness. Surgical emphysema of left side developed later, and next morning dullness of flanks, impaired L.D., and spreading tenderness were noted, with respiration 40, pulse 140 and very weak	Died 13 hours after reception of injury. Death probably due to thoracic condition, but included on account of abdominal signs.
18	66	Shrapnel wounds: Two, left buttock; one, left scrotum; one, dorsum of penis; one, venter of penis. Abdomen rigid, tender below umbilicus, and motionless on admission 2½ hours after reception of injury. Bladder not distended	Died 29½ hours after reception of injury.
19	70	Wound, eighth rib in R.N.L. Admitted 2½ hours after reception of injury. Developed hiccough and vomiting, dullness in both flanks, and some tenderness. Bilious discharge from wound	Died 30 hours after reception of injury.
20	75	Wound about eleventh right costo-vertebral junction; no exit. Admitted 3½ hours after reception of injury. Pain in and inability to use both lower limbs. Can move toes and both feet. Right limb rather stiff. Knee jerks present both sides. Bladder paralysed. Abdomen distended, tender above symphysis, immobile; recti rigid. Slight hiccough	Discharged on second day after reception of injury. (? Died soon after reaching hospital ship.) Probably no intra-abdominal lesion.
21	79	Bullet entrance about tenth rib in right posterior axillary line. Exit immediately below L.C.M., about 4 inches from mid-line. Admitted 14½ hours after reception of injury. Abdomen distended, rigid, and moves poorly	Discharged on second day after reception of injury.
22	81	Bullet entrance below and internal to angle of left scapula. Admitted 3½ hours after reception of injury. Developed subcutaneous emphysema of right side of chest and abdomen; also some abdominal rigidity and tenderness to right of umbilicus	Discharged on day after reception of injury. (?) Any intra-abdominal injury.

TABLE I—*continued.*

Number	Number in series	Nature of injury	Result
23	82	Wound 4 inches below left anterior superior iliac spine. Bruise perineum. Wound also left arm. Admitted 10 hours after reception of injury. Pale; weak; thready pulse. States he has lost much blood. Slight abdominal distension on day after admission. Abdomen remained mobile and fairly soft. No dullness in flanks. (Case regarded as one suffering from the effects of severe hæmorrhage at the time of the injury, and not as one of intraperitoneal trouble, and treated accordingly.)	Died 51 hours after reception of injury. Post-mortem: Free blood-stained fluid in pelvis. Track from entrance wound could be felt passing transversely inwards towards perineum, with a side-track upwards towards L.I.F., but in no place could a communication between this and the peritoneal cavity be demonstrated.
24	93	Entrance 4 inches to left of umbilicus, no exit. Admitted 6 hours after reception of injury. Abdomen tender and rigid, especially in lower half. Moves poorly. Impaired L.D., and flank dull, right flank resonance impaired	Died about 60 hours after reception of injury.
25	95	Bullet entrance right sacro-iliac joint; exit eighth rib in right axilla. Admitted 2¾ hours after reception of injury. Bleeding. Emphysema around exit. Some abdominal tenderness. Next day, rigidity. Still external hæmorrhage. Pulse-rate rising and strength falling rapidly	Died about 30 hours after reception of injury.
26	96	Shrapnel wounds, head, back, and abdomen. Admitted 2½ hours after reception of injury. Vomiting and collapsed. Considerable external hæmorrhage. Abdomen became rigid with diffuse tenderness and diminished mobility. Pulse became weak, thready, rapid, and uncountable	Died about 22 hours after reception of injury.
27	101	Bullet entrance left buttock. Appearance of wound suggested that bullet took a downward course and had not entered abdomen. Admitted to "abdominal ward" for observation on account of abdominal pain and rigidity. Vomited shortly after being wounded. Admitted 4 hours after being wounded: respiration rapid. Next day, abdomen soft; moves well. Epigastric tenderness. No vomiting, but hiccough. Respiration 40, pulse very weak and uncountable	Died about 30½ hours after reception of injury.
28	102	Shrapnel entrance tenth space below angle of left scapula. Bullet under skin just below C.M. in R.N.L. Admitted 30½ hours after reception of injury. Emphysema around wound. Abdomen rigid and motionless, left flank dull. Slight vomiting. Pulse feeble	Died on third day after reception of injury.

TABLE I—*continued.*

Number	Number in series	Nature of injury	Result
29	103	Shrapnel wounds: right flank; umbilical region; fourth space just to left of sternum; right iliac region. Admitted 1½ hours after reception of injury. Abdomen rigid, distended and tender. L.D. absent. Respiration rapid; pulse very feeble	Died on day after reception of injury.
30	104	Shrapnel wound immediately above symphysis pubis. Admitted 10½ hours after reception of injury. Dull in L.I.F. Large swelling in left iliac region with considerable discoloration of skin.	Discharged on day after reception of injury.
31	140	Wound of chest and abdomen. No details of exact locality, but apparently entrance and exit wounds. No record of time of reception of injury. Collapsed, pale, and appeared to be moribund on admission. Pulse 152, thready: respiration 48. Abdomen retracted and rigid. L.D. absent. Vomiting blood. Vomiting ceased; abdomen became softer; but respiration increased to 60, and pulse became quite imperceptible	Died on day after admission.
32	142	Bullet wound abdomen, with protruding fat. Compound fracture left femur. On admission, pale and collapsed. Abdomen rigid and immobile. Pulse rapid, weak and thready	Died on day after admission.
33	150	Entrance right loin (line of angle of scapula at lowest level of C.M.). Exit about ninth rib in right posterior axillary line. Admitted 10¼ hours after reception of injury. Abdomen rigid; mobility impaired. Slight rigidity continued, but was the only sign throughout which suggested internal trouble. Wound also right thigh	Discharged on third day after reception of injury.
34	175	Bullet entrance immediately above iliac crest in left posterior axillary line. Exit 1½-2 inches below iliac crest in right axillary line; dirty greyish-green offensive slough. Admitted 62 hours after reception of injury. States that he lay out for 48 hours before being found by bearers, and during this time had nothing but water. On third day had slice of bread and marmalade. On admission, abdomen soft, mobile, not tender. L.D. appeared to start abnormally high and be somewhat impaired at C.M.	Discharged on third day after reception of injury.
35	176	Shell wound left buttock; much bleeding; plugged. Wound also left side of abdomen. Very collapsed. Pulse weak and rapid, about 120	Died on day of admission.
36	188	Bullet entrance left posterior axillary line at level of nipple. Exit to left of spine about twelfth thoracic level. On admission, 7 hours after reception of injury, abdomen rather rigid and tender; movement limited; dull both flanks; L.D. normal; shooting abdominal pain; respiration 24; pulse 82, fair volume and tension. Next day, pain less; abdomen softer and more mobile; poor note both flanks. In evening, abdomen soft, not tender, moves fairly; no pain; right flank resonant, left poor note	Discharged on second day after reception of injury.
37	189	Chest wound right side, exact locality not noted. On admission, large patch of emphysema around wound; extreme dyspnœa; very pale and almost pulseless; abdomen tender, rigid, and almost motionless	Died on day of admission.

TABLE I—*continued.*

Number	Number in series	Nature of injury	Result
38	190	Bullet entrance right buttock just below iliac crest. On admission, 5 hours after reception of injury, abdomen somewhat rigid and tender; pulse weak and rapid. Next day, pulse very weak and rapid, uncountable; hiccough; right flank dull and rigid, abdomen elsewhere fairly soft; left flank poor note; L.D. normal	Died on day after reception of injury.
39	199	Shrapnel wound 1½ inches above iliac crest in left posterior axillary line. On admission, within 1 hour of reception of injury, abdomen soft; no physical signs of intra-peritoneal or visceral lesion detected. Twelve hours later, abdomen somewhat rigid, tender on left side, moves poorly; slight obliteration of L.D. at C.M.; right flank resonant, and poor note; has vomited; pain left side; pulse 120, fair volume and tension. Bad night with retching. Next morning, restless; abdomen somewhat rigid, moves poorly; tender left side; flanks resonant; L.D. normal; respiration 32; pulse 156, very weak.	Died on day after reception of injury.
40	203	Bullet entrance below and in front of left shoulder; no exit. No emphysema around wound; much hæmorrhage. On admission, 3 hours after reception of injury, pale and collapsed; pulse very weak; complains of paralysis of lower limbs. Later, abdomen very rigid and tender; right flank dull, left resonant; L.D. normal; respiration 32; pulse too weak to count; right axilla dull. Lower limbs stiff and rigid, right more so than left. Feet very cold and pale; thighs and legs bluish. Knee-jerks and ankle-jerks not obtained	Died on day of reception of injury. [Abdominal symptoms probably largely due to spinal injury.]
41	206	Bullet entrance about ninth rib in right posterior axillary line; bullet excised at Field Ambulance from about tip of eighth right rib. On admission on day following reception of injury, abdomen somewhat rigid, slightly tender, movement limited; right flank resonant, and poor note; L.D. normal; respiration 32, pulse 64; fair volume and tension. Later, complained of abdominal pain, but abdomen softer. Poor night. Next day, abdomen, left side soft, right somewhat rigid and tender; right flank dull, left resonant; respiration 24, pulse 68. Still some tenderness in R.I.F. when discharged.	Discharged on second day after reception of injury.
42	220	Large lacerated shell wound lower lumbar and sacral region. Fæcal fistula	Died on second day after reception of injury.
43	243	Entrance (? rifle bullet) about ninth rib in posterior part of left axilla. No exit. Some external hæmorrhage. On admission, about 5 hours after reception of injury, abdomen fairly soft, moves moderately, slight diffuse tenderness. Flanks resonant; L.D. normal; respiration 32; pulse 132, feeble	Died 25 hours after reception of injury.

TABLE I—*continued.*

Number	Number in series	Nature of injury	Result
44	244	Large irregular wound: A, about ninth rib in posterior axillary line; B, just below C.M. in axilla; is apparently deep and is plugged. On admission, about 5½ hours after reception of injury, abdomen fairly soft, moves moderately, tender in right half and in L.I.F.; right flank dull, and poor note; some diminution of L.D. at C.M.; respiration 16; pulse 72; emphysema around chest wound and bruising around both. Tenderness cleared up, and on second day discharge from lower wound became ammoniacal	Discharged on second day after reception of injury.
45	246	Entrance 2 inches to right of mid-line at level of umbilicus. Exit, R C.M., 1 inch mesial to N.L. On admission, about 5½ hours after reception of injury, abdomen somewhat distended, but fairly soft, movement poor; L.D. normal: left flank resonant, right impaired note; respiration 40, pulse weak, rapid, and uncountable. Twenty-four hours later, abdomen still fairly soft; not tender, moves fairly; L.D. normal; flanks resonant; respiration 32; pulse 136, very weak. Next morning, restless; pulse very weak, rapid, and thready; abdomen soft; left flank dull; right impaired note	Died on second day after reception of injury.
46	248	Two wounds at back and lower part of scrotum. On admission, about 12 hours after reception of injury, abdomen somewhat rigid, tender, moves very slightly; flanks resonant; L.D. obliterated; respiration 36; pulse weak, rapid, and uncountable	Died on day after reception of injury.
47	252	Bullet entrance ½ inch above iliac crest towards posterior axillary line. No exit. On admission, 9 hours after reception of injury, abdomen fairly soft, but right side slightly tender, movement fair; flanks resonant; L.D. normal; respiration 16, pulse 84; good volume and tension. Developed dullness in left flank with slight resistance and tenderness on left side. Resistance and tenderness cleared up, but dullness persisted when patient discharged. Pulse became more rapid, up to 120, and weaker, but quietened down to 96 before discharge	Discharged on third day after reception of injury.
48	260	Wound with appearance of shrapnel entrance above umbilicus. Second wound, gutter-shaped, over ninth and tenth left ribs — ? entirely superficial and not exit of umbilical bullet. On admission, 21 hours after reception of injury, collapsed: respiration 44; pulse at wrist almost imperceptible; abdomen somewhat rigid and tender, but moves fairly well; L.D. absent; right flank resonant, and impaired note. Became restless, with much abdominal pain, and never recovered sufficiently to warrant operation	Died on day after reception of injury.

TABLE II.

Twenty-three Cases Operated on in the Station.

Number	Number in series	Nature of injury	Nature of operation	Hours from injury to operation	Result	Remarks
1	2	Wound of deep epigastric vein with perforation of peritoneum	Ligature; drainage of peritoneum and extra-peritoneal tissues	21	Death about 18 hours after operation	—
2	8	Left lumbar wound. Hæmorrhage into peritoneum	Pelvic drainage	29	Discharge on second day after operation	No apparent active hæmorrhage at time of operation.
3	14	Left hypogastric region. Injury to bladder with extravasation of urine	Drainage..	21½	Death about 12 hours after operation	—
4	29	Entrance left buttock, exit to left of mid-line above pubes. Hæmorrhage into peritoneum	Pelvic drainage	26	Death about 15½ hours after operation	—
5	56	Entrance right flank. Bullet subcutaneous in appendix region. Signs of early peritonitis	Bullet excised, free gas and intestinal contents in peritoneum. Pelvic drainage	4	Death about 47 hours after operation	—
6	90	Entrance, back and inner aspect right thigh, almost in perineum; no exit. Intraperitoneal hæmorrhage	Pelvic drainage	36	Discharge on day after operation	—
7	91	Shrapnel entrance right lumbar region, excised before admission from anterior abdominal wall about 4 inches to right of and slightly above umbilicus. Small localized intraperitoneal abscess in R.I.F.	Abscess drained.. ..	24	Discharge on day after operation	—
8	99	Shrapnel entrance R.I.F. Hernia of omentum. No exit	Omentum ligated and removed. Pelvic drainage	4	Death about 29 hours after operation	--
9	126	Wound 2 inches long over left kidney, had appearance of bayonet wound, but said to be shrapnel. Hæmorrhage into peritoneum. Hæmaturia on admission	Pelvic drainage	24	Doing well four days after operation. Taking fluids. Temperature normal	—

TABLE II—*continued*.

Number	Number in series	Nature of injury	Nature of operation	Hours from injury to operation	Result	Remarks
10	136	Shrapnel entrance 2 inches below and to right of umbilicus. Perforation of peritoneum just internal to external iliac vessels, bone splintered. Slight hæmorrhage	Drainage of pelvis and extraperitoneal tissues	7	Fæcal fistula developed on evening of day after operation. Died following day	—
11	144	Bullet entrance, L.I.F.; no exit. Deep epigastric vessels wounded, peritoneum perforated, blood and serous fluid in peritoneal cavity. Gut intact	Deep epigastric vessels ligatured and divided. Pelvic drain	12	Tube removed 58 hours after operation, and patient discharged the following morning	—
12	183	Shell wound right buttock and immediately to left of sacrum. Fæcal fistula sacral wound; wound also below angle of right scapula. Pale and collapsed on admission immediately after reception of injury	Laparotomy and drainage. Numerous adhesions present. Local anæsthesia	48	Died shortly after operation	Treated with saline infusions and morphia to improve general condition sufficiently to warrant operation. Practically moribund before operation but revived slightly after morphia and intravenous saline, and was operated on while in this condition.
13	185	Shrapnel wound, ninth rib below angle of scapula, right side; exit immediately above and to left of umbilicus. Omental hernia. Abrasion on surface of gut. Hæmorrhage into peritoneum	Exit wound enlarged. Abrasion covered over. Omentum ligated and removed. No bleeding point located. Drainage of pelvis and track of bullet	3	Died on following day	—
14	187	Shell wound of epigastrium. Hæmorrhage into peritoneum and probable gastric perforation	Opened below umbilicus. Blood and (?) small amount of gastric contents; no perforation located. Pelvic drainage	14½	Died about 40 hours after operation	—

15	194	Shrapnel wound right side of back, ? small fæcal fistula	Median incision below umbilicus. Blood and pus in peritoneum. Pelvic drainage.	40	Died on day of operation	—
16	231	Bullet entrance R.C.M. in posterior axillary line, exit tenth left rib in anterior axillary line. Omental hernia	Omentum ligatured and removed. Stump left in situ and not returned to peritoneal cavity	26	Discharged to hospital ship on day after operation	—
17	234	Bullet entrance 1½ inches below iliac crest in posterior axillary line. Exit R.I.F. Fragments of bone extra-peritoneal, pus intraperitoneal tracking towards pelvis	Exit wound opened up. One tube into pelvis, and one extraperitoneal tube to bone	50	Died on day after operation	Admitted 49 hours after reception of injury.
18	236	Bullet entrance back and outer side of right thigh, no exit. On admission about 3 hours after reception of injury, some shock; abdominal pain; slight abdominal rigidity. Rigidity increased, with some distension	Exploratory incision. Peritoneum full of pus and (?) fæcal matter. Drainage	25	Died on third day after operation	—
19	240	Bullet entrance right loin, no exit. Tenderness, rigidity and ill-defined mass in R.I.F., which was dull on percussion	Incision over mass. Appendix healthy. Gauze drain passed down to large localized inflammatory mass around cæcum	80	Discharged to hospital ship on day after operation. Free discharge of pus from wound	Detained three days in 1st E. Lancs F.A., operation on admission to C.C.S.
20	253	Bullet entrance right loin; no exit. Perforation of gut. Abdomen rigid, tender, motionless. L.D. obliterated	Incision R.I.F. Free fluid and gas. Pelvic lavage and drainage	26	Doing well about 6 days after operation	Discharged to hospital ship on third day after operation. Local condition satisfactory, but tongue dry, and patient running temperature of 101° F. to 102° F. About third day on hospital ship developed rose spots and was diagnosed as enteric, but was doing well. Subsequently heard that he recovered.

TABLE II—*continued.*

Number	Number in series	Nature of injury	Nature of operation	Hours from injury to operation	Result	Remarks
21	255	Two wounds below right iliac crest and behind anterior superior iliac spine. Wound left buttock—incision from which bullet removed in Field Ambulance. Wound also right shoulder, superficial. Abdomen very rigid, tender, and motionless; L.D. impaired; resonance of both flanks impaired. Perforation of gut with hæmorrhage	Median incision below umbilicus. Free gas and much blood. Pelvic drainage	9	Died 16 hours after reception of injury	—
22	258	Bullet entrance left side below iliac crest; no exit. Perforation of gut, and intraperitoneal hæmorrhage	Incision L.I.F. Perforation closed hurriedly. Patient too bad to allow of systematic search for site of hæmorrhage or further injury to gut. Pelvic drainage	12	Died about 111 hours after operation. Fæcal fistula	Discharged to H.S. "Delta" on fourth day after operation. Journey to ship in evening gave rise to vomiting, and in early hours of morning pat ent became very bad and died after about 15 minutes' warning.
23	259	Wound of hypogastrium. Abdomen rigid, tender, and moves poorly. Pain above pubes. Flanks resonant; L.D. normal; respiration, 32; pulse, 84. Intestinal perforation and hæmorrhage into peritoneum	Wound enlarged and track of bullet followed. Blood and free gas in peritoneum. Pelvic drainage	12	Discharged to H.S. "Gascon" on third day after operation. Fæcal fistula developed on day after operation. Subsequently heard that he recovered	At operation perforation thought to be between two adherent coils of gut, well shut off. These were left undisturbed at bottom of wound.

TABLE III.

THREE CASES OPERATED ON, BUT SHOWING NO PERITONEAL OR VISCERAL LESION.

Number	Number in series	Nature of injury	Nature of operation	Hours from injury to operation	Result	Remarks
1	130	Entrance wound R.I.F., no exit ..	Wound opened up. Bullet apparently had not entered peritoneum	2	Discharged to hospital ship on day after reception of injury	
2	172	Position of wound not noted, beyond that it was in the back. On admission, 12 hours after being wounded, abdomen rigid, tender, and motionless. Flanks resonant; L.D. normal; respiration 20, irregular; pulse 92, weak, and drops an occasional beat. ? Slight hyperæsthesia right lower limb. Knee jerks, ankle-jerks and plantar response not definitely obtained. Six hours later: abdomen rigid, tender and motionless; right flank dull; slight distension. Respiration 16; pulse 100, weak. Operation 1½ hours later. Urine not passed till catheterized	Median exploratory laparotomy below umbilicus. Peritoneal cavity quite healthy. Closed in layers	19½	Discharged to H.S. "Grantully Castle" on day after operation. Seen on board 4 days later and was then doing satisfactorily	Condition on day of discharge to hospital ship: Legs feel more comfortable. Abdomen fairly soft, less tender, moves slightly, and flank resonant; right impaired note; L.D. normal. Bladder does not appear distended — incontinence during night. Pulse 100. Knee-jerks, ankle-jerks, and plantar response not obtained. Abdominal reflexes present. Cremasteric reflexes sluggish.

TABLE III—*continued.*

Number	Number in series	Nature of injury	Nature of operation	Hours from injury to operation	Result	Remarks
3	264	Shrapnel entrance immediately above left iliac crest, about posterior axillary line. On admission 2 hours after reception of injury, abdomen rigid, tender, and moves poorly. Pulse 84, fair volume and tension	Median exploratory laparotomy below umbilicus. No signs of hæmorrhage, peritonitis, or perforation. Wound closed in layers. Recti very strongly developed and relaxed with great difficulty under anæsthetic	2½	Discharged to H.S. "Delta" on third day after reception of injury. Condition satisfactory	Morning after operation: Feeling better. Still some abdominal tenderness; respiration, 24; pulse, 100; abdomen moves moderately. Same evening: Temperature, 101·6° F.; pulse, 96, fair volume and tension; respiration, 28; abdomen fairly soft, moves moderately; slight tenderness R.I.F. Next morning: Temperature, 99·2° F.; pulse, 92, good volume and tension; respiration, 22; abdomen fairly soft, moves satisfactorily, not tender in R.I.F. Evening: Temperature, 100° F.; pulse, 96; abdominal condition as this morning; tongue dirty. Next morning (day of discharge): Temperature, 99·4° F.; pulse, 72, fair volume and tension; abdomen soft and moves well.

In conclusion, we would both express our sincere thanks to Lieutenant-Colonel Humphry, R.A.M.C., commanding No. 11 Casualty Clearing Station, for frequent advice and assistance in dealing with the cases under review.

NOTE BY CAPTAIN W. C. HORTON, R.A.M.C.

When we first started getting abdominal wounds I was strongly opposed to operating on them, as I had heard accounts of the bad results obtained in Field Ambulances in France, and I still think that through and through rifle bullet wounds should be treated by rest in the Fowler position, morphia and starvation; but in cases of penetration of the peritoneum by shrapnel bullets and pieces of shell it was soon obvious that this method of treatment was entirely unsuccessful. Practically all these cases died.

Before leaving England I had read accounts of the results of doing extensive operations in field ambulances for these cases, and they seemed to me to offer little more hope of success than the expectant form of treatment.

The conditions in the field are not favourable to big abdominal operations, nor is the condition of the patient, as a rule, such as to stand the inevitable shock; so I suggested to Captain Udall that we should try, in those cases which without surgical interference would certainly end fatally, the effect of draining the pelvis, an operation that only took a few minutes to perform and that caused very little shock. The results seem to me to be, at any rate, as good as those of any of the more heroic forms of treatment; moreover, another advantage of this method of treatment is that it can be performed by anyone familiar with the ordinary technique of abdominal surgery, but who is not sufficiently experienced to perform rapidly extensive resections of gut.

A large number of these cases are almost moribund on admission, and inevitably die whatever the treatment. In some of the earlier cases we watched them for a time, and only operated when signs of peritonitis developed, but soon found that the results of this were not satisfactory.

I am now convinced that all cases of injury to the peritoneum by shrapnel bullets and pieces of shell should be subjected to an operation, and that the operation should be performed as soon as possible after admission.

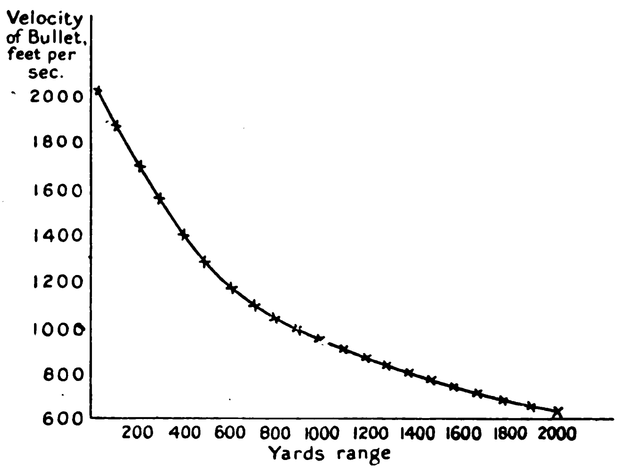
Royal Army Medical Corps, 3rd Corps Medical Society.

CLINICAL NOTES ON PENETRATING WOUNDS OF THE ABDOMEN.

By Lieutenant H. H. SAMPSON, F.R.C.S.
Royal Army Medical Corps.

I propose to mention some points in connexion with wounds of the abdomen, and to read notes on some cases which have been treated recently at the special hospital at ———, five kilometres behind the firing line.

The extent of the visceral injury caused by a rifle bullet in the abdomen depends to a large extent on the distance which the bullet has travelled before impact. The most extensive wounds are caused when the range is less than 500 yards. Intestine may be torn completely across, or show large open wounds with everted edges. Solid organs present radiating lacerations. These wounds besides being extensive bleed profusely.



Velocity range curve of rifle bullet.

With a range of over 500 yards, however, the wounds are more limited in extent, but still bleed freely. As the range lengthens, the damage becomes more confined to the actual tract of the bullet.

It is interesting to consider the cause of this influence of range on the character of the wound. At first I thought it was due to instability

of the bullet which is known to exist during the first portion of its flight. I have here a diagram showing by means of a curve the relation between velocity and range. It shows how rapidly the velocity diminishes during the first few hundred yards of a bullet's flight. I think high velocity is the cause of the extensive character of visceral wounds at short ranges. The term velocity is meant to include both the translation and the spin of the bullet, and it is probably the latter which is the more destructive force. The importance of primary hæmorrhage lies in the fact that there is but little tendency towards spontaneous arrest. When seen three or four hours after receipt of the injury, small arteries in the wounded bowel are still spurting vigorously. In fatal cases, death is almost invariably due to primary hæmorrhage.

It becomes obvious, therefore, that on this account alone every effort should be made to convey abdominal wounds with the least possible delay to a place which is equipped for their operative treatment.

Peritoneal Perforation without Visceral Injury.

Apart from those cases where a bullet has only a short intraperitoneal course, it is possible for a bullet to traverse the peritoneal cavity in an area occupied by intestines without causing perforation of the viscera with which it must come in contact. One such case has passed through the hospital.

The entrance wound was in the mid-Poupart line, just below the level of the umbilicus. The exit wound was behind in a corresponding position. When seen 2½ hours after the injury, signs of internal hæmorrhage were present; the abdomen was rigid and tender.

Operation revealed intraperitoneal hæmorrhage, which was proceeding from torn ileocolic vessels adjacent to the cæcum, but there was no perforation of any viscus. No sign of abrasion or bruising could be discovered in the small intestine. Bleeding points were ligatured. Recovery was uneventful. This case is unique in my experience.

Wounds with a very short intraperitoneal course may implicate omentum only. In these cases the omentum shows a great tendency to prolapse through the wound. If the injured omentum is excised and the peritoneum closed, these cases do uniformly well. There is apparently little danger of suppuration occurring in the peritoneal cavity, although the rest of the wound may be badly infected.

Peritoneal Perforation with Visceral Injury.

Wounds of the small intestine are generally multiple, but are usually confined to one segment of bowel.

Cpl. H., of the South Staffordshire Regiment, was hit in the abdomen at about 250 yards range. He made the interesting statement that he felt no impact. His right leg suddenly became useless, and he fell to the

ground. About ten seconds later he experienced agonizing pain in the abdomen. This continued without remission until operation was performed. He arrived at the special hospital within one hour of being hit. The abdomen was then rigid. There was a small entrance wound in the middle line below the umbilicus and an exit wound about the size of a halfpenny in the right buttock. At the operation seven perforations were found in small intestine. There was a large quantity of free blood in the peritoneal cavity. A segment of lower ileum, measuring twenty-four inches in length and containing all the perforations, was excised. End-to-end anastomosis was performed. The peritoneum was mopped dry and then closed without drainage. There was some vomiting for three days, but the patient rallied well. A letter from England six weeks after the injury informs us that he is walking about and feeling quite fit.

Another case of uncomplicated small intestine injury:—

Pte. R., Northumberland Fusiliers, was hit by a bullet which ricochetted off an iron roof in the front line trenches. He described the impact as a blow without any pain. This patient arrived at the hospital in a little over an hour from the time he was wounded. There was a large entrance wound with bruised edges in the anterior abdominal wall below and to the left of the umbilicus. At the operation this wound was excised and converted into a vertical incision. A distorted bullet was found lying free in the peritoneal cavity, adjacent to four perforations in the small intestine. Intraperitoneal hæmorrhage was small in amount; three feet two inches of ileum was excised, and end-to-end anastomosis performed. Portions of clothing were found scattered throughout the peritoneal cavity, mostly adhering to omentum. After irrigation with eusol and saline, the abdomen was closed without drainage. Some infection of the abdominal wall occurred. This remained local and quickly subsided. The clinical chart indicates the progress. Five weeks after the injury this patient wrote from England to say that he was walking about, but still felt a little weak.

It is surprising how frequently injury to small intestine is complicated by injury to the iliac veins or inferior vena cava. The large arteries either escape damage or more probably produce a fatal result before the patient can be moved; on the other hand, injury to the great veins is often found. This additional source of hæmorrhage has in my experience always led to a fatal result.

Wounds of the colon are often complicated by injuries to other viscera. These cases show a high mortality. If, however, the injury is confined to the colon, the outlook is more hopeful, provided that operation is performed before widespread peritoneal infection has occurred. The lax wall of the colon allows instant escape of contents in direct contrast to the small intestine, in which there is little tendency for leakage to occur for several hours.

Lieutenant I. was operated on within one hour of being hit in the left

flank. The bullet which caused this wound had travelled more than one thousand yards. The visceral hæmorrhage was slight. There was a single linear wound of the descending colon, with fæcal contents soiling the surrounding peritoneum. A Paul's tube was tied into the colon. Rubber drainage tubes were inserted into the subphrenic and iliac regions. Peritonitis remained local, and a good recovery ensued. Preparations are now being made in England for closure of the artificial anus.

In another case, Lance-Cpl. E., 2½ hours elapsed between injury and operation. The descending colon was almost completely severed. There was profuse internal hæmorrhage. Division of the colon was completed. A Paul's tube was inserted into each end. A suprapubic drain was used in this case. Recovery was rapid and uneventful.

The case of Pte. T., Suffolk Regiment, was complicated by the fact that the bullet had entered the abdomen through the innominate bone. There were six perforations of cæcum and ascending colon, varying in size and mostly caused by fragments of bone. The edge of the liver was lacerated, two pieces being completely detached. The edges of the cæcal wounds were trimmed, sutured and invaginated. A drain was inserted with the right flank. The exit wound through the anterior abdominal wall was filled with gauze, which passed down to the wounded liver. A few hours later, during an attack of vomiting, the patient felt something give way. Examination revealed the transverse colon and omentum lying in the dressings. The prolapse was reduced under an anæsthetic. The anterior wound was then completely stitched.

In spite of this unfortunate event, the patient made a good recovery. No leakage occurred from the cæcum. He writes the following from Calais three weeks after the injury :—

"Dear Sir,—I am pleased to be able to write you to say I am getting on quite well, and know you will be pleased to hear this for I think you thought I'd have a rough journey to pull through. Well, I thought I might with luck, but I *was* bad for two weeks . . . ."

Wounds of the stomach bleed freely, but, if uncomplicated, respond well to operative treatment.

Cpl. D. J., Yorks and Lancs. Regiment, was struck in the back by a small fragment of shell. He arrived at hospital 2½ hours after receipt of the injury. There was a small entrance wound over the left erector spinæ at about the level of the first lumbar vertebra. The abdomen was rigid and tender. He had vomited once.

Operation revealed perforations of both anterior and posterior walls of the stomach, two perforations of the jejunum close to the duodeno-jejunal flexure, and perforation of the thin anterior edge of the liver. The shell fragment was found embedded in the diaphragm beneath the left costal margin. The visceral wounds were trimmed, sutured and invaginated. The only drain used was a wick of gauze down to the

wounded liver. Recovery was uneventful. A message from Calais states that the wounds are healed and the patient well.

Turning to wounds of the solid organs, those of the liver give the best results. In simple perforations, hæmorrhage is slight; bile drains away for a few days; recovery is the rule. A bullet at short range will split open the liver as though with a knife. In such cases hæmorrhage is free, but is easily controlled at operation. Extensive necrosis of the neighbouring liver substance sometimes occurs. This is often seen in fatal cases.

The spleen is seldom injured alone. Its injury is often associated with that of the left kidney, pleura and lung.

The following are the notes of such a case:—

Rifleman T., 11th Rifle Brigade, felt a sudden blow in the abdomen while lying behind a cart in front of our wire. He arrived in hospital about five hours later, and was then blanched, cold, and collapsed. There were signs of intraperitoneal hæmorrhage. There was an entrance wound in the side over the left lower ribs. On opening the abdomen the peritoneum was found to contain a large quantity of free blood. The spleen and left kidney both showed lacerated perforations. The splenic pedicle was partially severed. The bullet track passed towards the muscles of the back to the left of the vertebral column. Profuse hæmorrhage was taking place from the splenic pedicle and from the vertebral region. The spleen and left kidney were excised. The region of the spine was firmly packed as no bleeding points could be seen. The bullet was not located.

The patient was now so collapsed that the operation was curtailed by simply filling the left loin with gauze and leaving open the centre of the abdominal incision.

Chest symptoms prevented further operative measures until the eleventh day, by which time infection of the loin had already occurred. Drainage tubes were inserted through a posterior counter opening. Eight ounces of sterile blood were aspirated from the left pleura. Signs of septic absorption still continued, and on the twenty-fifth day a rib was resected in order to drain the left pleura. No infection was established.

On the twenty-seventh day the lower posterior wound became fæcal. The patient was now in an almost hopeless condition. All the wounds were infected. The temperature averaged 102° F. at night, 100° F. in the morning. The pulse rate varied from 120 to 140 per minute. The respirations rate varied from 26 to 40 per minute. Generalized bronchitis was present. Fæces were constantly escaping from the left loin.

The pleura was irrigated twice daily with eusol and saline. On the thirty-eighth day the temperature remained normal for twenty-four hours for the first time since the injury. From this point improvement was rapid and continuous.

A medical officer from Calais writes to say that the patient was

transferred to England nine weeks after the operation, and that he was then in a very satisfactory condition.

You will notice that all the cases I quote have had a successful result. I want to make it quite clear that such cases are looked on rather as "brands plucked from the burning" than the normal result of these injuries.

There is one point on which too much emphasis cannot be laid, that is the importance in these cases of operation at the earliest possible moment. To secure this end perfect co-operation is essential. At the special hospital the operating theatre is kept in constant readiness, and the operation is usually commenced within fifteen minutes of the patient's arrival. But, of course, the most difficult task lies with those responsible for the transference of the case from trench to hospital.

DISCUSSION.

Colonel SKINNER said he was particularly interested, more from an administrative point of view. The speed with which the cases were transferred from the trenches to the hospital greatly added to the chances of recovery. This speeding up rested with the medical officers. He had read Sir A. Bowlby's Bradshaw lecture, published in the *British Medical Journal*, where he pointed out the greater damage done by bullets when fired at shorter ranges, advancing the theory of compressed air in front of the bullet. Also that the bullet probably has an "explosive" effect. Frequently the bullet also turns over on its course. Its velocity must be imparted to surrounding structures; so much so that Sir A. Bowlby mentioned a case where the bullet had travelled across the abdominal wall, not entering the abdomen, but post mortem the bowel was found disorganized. In cases of wounds of back and buttock where the wounds might not suggest an abdominal injury, it is wisest to send them into the abdominal and chest department of the 26th Field Ambulance. He said that Mr. Sampson had had 60 per cent of recoveries including cases brought in moribund.

Captain FRASER: It is often difficult to know when the peritoneum is opened. Recently I have found by experiment that if the blood pressure is low the peritoneum is probably opened.

Apropos of injury due to the proximity of the wounded person to the discharged rifle, I have seen a case where accidentally a soldier was shot through the abdomen at 250 yards distance without any extensive injury of the bowel. Probably the amount of injury depends a great deal on the position of the bowel when hit.

I have tried various kinds of anæsthesia: spinal, ether, chloroform, and lately intravenous ether; here the results are good, not only is there an anæsthetic effect, but a volume of fluid is given at once to replace the loss of blood.

Lieutenant-Colonel PICKARD said that Sir V. Horsley some time ago

pointed out the importance not only of the velocity of the bullet, but also its spin which sent out radio-fissures of energy along its track. He read in the *British Medical Journal* a paper where the damage done by a bullet penetrating the abdomen was regarded as analogous to the splash of a hard substance striking a fluid. He described the well-known trick of throwing a stone up in the air and into a pond, trying to make the least amount of splash; here the splash was least when the stone dropped vertically.

Captain Soltau asked first, why Mr. Sampson used a Paul's tube in two of the colon cases and invaginated the wound in the other, and second, if he had swabbed out with ether.

Captain McNee had examined livers pierced by bullets and noticed necrotic changes in the tissues at least two inches from the track. In one case the bullet had pierced the kidney and the upper pole and the lower pole showed necrotic changes although there was not any damage to the intervening tissue. In one eight-inch loop of small intestine he had seen one rosette wound and about nine linear slits; it was highly improbable that the bullet pierced through ten places. He suggested that possibly the slits were due to muscular action.

Colonel Dunn asked Captain Fraser if he used an elaborate apparatus for intravenous injections.

Captain Fraser: No; only a Lane's bag.

Mr. Sampson, in reply, said in doubtful cases of peritoneal entrance he opened up away from the wound to prevent sepsis. If the compressed air theory of causing damage to abdominal organs was correct one would expect more damage at the entrance wound. The Paul's tubes were used in the two cases because two-thirds of the circumference of the colon was injured, in the other case the cæcum had two or three small perforations. He had not used ether as a peritoneal dressing.

CEREBROSPINAL MENINGITIS.

By Lieutenant H. R. BROWN.
Royal Army Medical Corps.

The following notes on cerebrospinal meningitis are founded on my experience of twenty-seven cases treated at 7th General Hospital since the end of October, 1915.

Cerebrospinal meningitis is an inflammation of the inner meninges caused by, or constantly associated with, a diplococcus which multiplies in the pia arachnoid spaces, and the cerebral ventricles, and sets up a leucocytosis in the blood and in the cerebrospinal fluid. In fatal cases pus is generally to be found on the ventricular surface of the brain, and sometimes at the base and in the ventricles. The presence of the cocci and especially of the leucocytes in the cerebrospinal fluid changes it from its normal condition of crystalline clearness to one which varies from

slight opalescence, through any degree of turbidity up to actual purulence. Further, the cocci are very frequently to be found in the nasopharynx, where they are sometimes associated with redness of the fauces, and nasopharyngeal catarrh. Occasionally they may be recovered from the blood, and post mortem from the pericardium, lungs, pleura or peritoneum. In a few cases there is an arthritis which may affect any joint, and in which the organism may also be found.

As to the mode of entry of the coccus into the meninges, where alone it gives rise to the symptoms which make up what we know as the disease, various theories have been advanced. It is quite certain that it can exist in the nasopharynx without causing any symptoms whatever, while in other cases it is associated with only a small amount of pharyngitis. Indeed, it is to be found in this position in a very large number of "contacts" who have lived under the same conditions as those under which the patient has contracted the disease.

Bruns and Helm (1907) obtained positive swabs from the throats of no less than twenty-two per cent out of 1,786 contacts. It seems probable, then, that the nasopharynx is the front door through which the enemy enters. Whether its subsequent course is through the accessory nasal sinuses and the ethmoidal or sphenoidal cells, or whether it is picked up by some over-zealous leucocyte who then returns to the blood-stream and there rejects the unpalatable morsel, setting up a septicæmia, or whether the leucocyte carries the coccus to the pia arachnoid spaces and there sets him free, or, finally, whether some other unsuspected channel of infection is followed, I must leave it to pathologists to say. The practical importance of the assumption that infection is through the nasopharynx lies in the light it throws on the varied question of epidemiology.

Cerebrospinal meningitis is an epidemic disease, but the cases in an epidemic, though closely grouped in time are apt to be widely distributed geographically. Thus out of about 190 cases treated in two hospitals here since January, 1915, only one had, so far as is known, been in close contact with another case of the disease. The rest were received from every possible front of the field. The difficulty of accounting for such a distribution of cases disappears at once if we assume that the "contacts" who have the meningococci in their nasopharynx are capable of acting as carriers and that the true epidemic is not one of cerebrospinal meningitis, but of meningococcus-infected persons, the immense majority of whom go about their duties undiscovered with no signs of illness, or at the most with a sore throat. It is only the small minority who develop meningeal symptoms that come under observation.

Epidemics occur in winter and early spring. Last year the rush of cases began on this front in February. Admissions to one hospital which in January had come in at the rate of from one to four per week, rose suddenly to twelve and even sixteen, and the average did not fall

below five per week till the middle of May. This confirms the experience of previous epidemics. In Prussia, for instance, in 1904-07, April invariably marked the crest of the wave which began to rise rapidly in February. Is this seasonal curve, due to cold weather, and consequent want of ventilation, where there is so much overcrowding that any want of ventilation produces a "close" atmosphere? or does it follow the seasonal curve of catarrhal diseases, which makes the nasopharynx a suitable soil for the reception of the germ? In favour of the former view is the fact that the medical and nursing staff who are in contact with cases, but under good conditions of ventilation and general hygiene seldom are found to have the infection in their throats. Numerous swabbings both at 10th Stationary and 7th General have always given negative results. In favour of the latter view is the fact that in slums where in civil life epidemics are most apt to occur, bad ventilation is not confined to the months between February and April. Probably both conditions are contributory factors.

Liability to the disease is found to decrease rapidly with age. Neave gives only seven per cent as over 25 years among soldiers. Our figures are much higher, six out of twenty-seven. But such statistics are of little value, as I do not know of any figures giving the age distribution of the soldiers in our present Army.

Lastly, soldiers appear to be specially susceptible. Of sixty-two epidemics in France recorded by Hirsch, forty-three were exclusively and six chiefly confined to troops. Possibly the reason for this lies in the physical strain to which they are often subjected. Meantime, until we know more about it, it is worth while to remember the advice of Sir W. Osler to medical officers in charge of troops, however difficult such advice might be to be put into practice: (1) Guard the young soldier especially against over-fatigue; (2) reduce to a minimum the circumstances favouring nasopharyngeal catarrh; (3) make possible combination of good ventilation with comfortable warmth for the men.

Clinical Features in the Present Epidemic.

Of the onset of the disease I can only speak from hearsay, and many cases come in unconscious or delirious, and without notes as to the initial symptoms. But where a history could be obtained, two symptoms were practically invariable.

(1) *Headache* which is recorded in every case except one where the first symptom is said to have been sudden unconsciousness.

(2) *Vomiting* which is again recorded in every case except one. The other early symptom were, in order of frequency, stiff neck, pains in the chest, back and legs, "pains all over," giddiness and shivering.

On admission, the patient is generally collapsed from his journey, and unless he has been well wrapped up and kept warm by hot water

bottles, he is very cold. As to his mental condition it may be anything from perfect clearness to coma, resistive stupor, or wild delirium.

The "characteristic" attitude so often described, lying on the side with flexed limbs and retracted head is by no means invariable. Quite often the patient lies on his back, and head retraction is exceptional within the first weeks. A flushed face, again which is supposed to be typical, was not more common than pallor. The rashes observed were various:—

(1) The "*spotty*" *rash* from which the disease appears to derive its popular name.

This was only seen in one case. It consisted of large purpuric spots three to four millimetres in diameter, of irregular outline, scattered thickly over the chest, shoulders, abdomen and upper part of the thighs. There were more on the back. One or two much redder in colour were on the face and eyelids, and there was a subconjunctival hæmorrhage in one eye. This rash bears some resemblance to the hæmorrhagic rash of typhus. It turned reddish-purple on the second day, pale lavender on the third, and had disappeared on the fourth.

(2) *Petechial rash.*—This resembles the last in colour and distribution and in fading in four days. But the spots are not more than two millimetres in diameter and closely resemble flea bites. It was seen in one-third of the cases, but on one occasion only made its appearance on the thirteenth day of the disease.

(3) *Erythema.*—This is something like a scarlatinal rash in appearance, but patchy in distribution and very evanescent. It was probably a rash of this sort that led to a case being sent in as erysipelas and another as German measles.

(4) *Macular rash.*—This is sometimes a perfect copy of a measles rash, so perfect that a patient was even admitted to our measles ward, and it was not until a few hours later, when the rash suddenly disappeared and the headache which had been moderate became intense, that the mistake was discovered.

(5) *Urticaria* is generally supposed to occur only in cases that had been treated with serum. One of our cases, however, that had been not so treated developed an intense urticaria.

(6) *Purpuric mottling.*—This appearance, which closely resembles post-mortem mottling, is sometimes seen on the extremities, and is, I believe, always a fatal sign.

Pain.

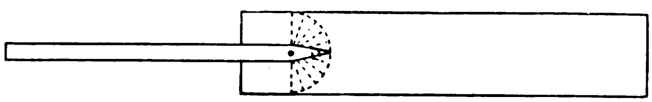
As a rule, the patient if conscious complains of severe pain—headache, backache, neckache, legache, all or any of them. The headache is not more often occipital than frontal. As a rule it is general. Even if for a short time the patient professes to feel quite well, the headache at any rate is not far off and many hours do not pass without a severe attack.

Nervous Symptoms.

It is when we come to these symptoms connected with the nervous system that we find the most characteristic signs of the disease.

(1) *Neck rigidity.*—Every case that I have seen has shown some stiffness of the neck. As Herden points out this stiffness unlike rheumatic stiffness, which is reduced by manipulation, is rather increased by attempts to overcome it. Further, the stiffness is a resistance to flexion in the middle line. Often there is much less resistance to rotatory movements, while in most cases attempts at flexion are very painful in others it seems to be quite painless—again distinguishing it from rheumatic stiffness which is always painful. Finally the interference with movements in cerebrospinal meningitis is generally abrupt and not elastic.

(2) *Kernig's sign.*—The well-known Kernig's sign seems never to be absent, and generally it seems to be fairly proportionate in amount to the severity of the case. I think it is worth while estimating and recording the amount of interference with extension. This is easily done with the patient in the supine position by flexing the thigh till it stands vertical to the bed, raising the leg as high as possible, and then measuring the angle between the thigh and the leg. It is convenient to make a measure for the purpose out of two pieces of wood, one of which is hinged on the other by a screw passing loosely through it near one end and fastened firmly into the second piece on which one can mark off an angular scale.



As in the neck stiffness, the resistance in the true Kernig's sign is a sharp one, feeling like a bony ankylosis, and not an elastic one.

Where the patient is in a condition of resistive stupor, or where there is any arthritis in the knee-joint, it is, of course, impossible to obtain this sign. Babinski's sign, Bruzinski's sign, the tache cérébrale, the scaphoid abdomen, and the condition of the superficial reflexes I have all found to be so variable as to be quite useless for diagnosis. The most characteristic Bruzinski's sign that I have seen was in a case where clear fluid without meningococci was obtained by lumbar puncture.

The knee-jerks are as a rule abolished or much reduced, but I have found them exaggerated in a few cases. In one which recovered very quickly there was a well marked ankle clonus.

Lumbar Puncture.

In all doubtful cases it is necessary to carry out a lumbar puncture and to have the fluid examined by a bacteriologist. The technique is quite easy and with ordinary care the danger seems to be nil.

In a few cases at first I used only local anæsthesia. This I have now quite given up in favour of general anæsthesia. The risk of a patient struggling and of having to dig for part of a broken needle is best avoided. As to position, it is quite immaterial whether the patient is laid on his right side or his left. What is essential is that he should be on the very edge of the bed with the knees well drawn up, the upper one resting on the lower, and the back as much arched as possible. In the absence of a Barker's needle an ordinary aspirator needle will answer the purpose. A serum needle is too short for an adult. The most convenient space is that between the fourth and fifth lumbar spines, i.e., immediately below the intercristal line. But any space from the second to the fifth lumbar will do. It is of course essential to identify the line of the spinal processes. Puncture in the mid line straight forward sometimes slightly upwards to a depth of three inches, and if successful fluid will appear. This may either drip or spurt from the needle. In my experience the pressure is no guide to diagnosis.

In the absence of meningitis the fluid is perfectly clear, but a slight admixture of blood, which may be unavoidable, will give it a little opalescence besides tinting it with red. If, however, it is colourless but opalescent, or thick or purulent, meningitis is certainly present.

The diagnosis between meningococcal, pneumococcal, and septic meningitis can only be made by examination of the fluid—though the discovery of middle-ear disease is a strong clinical point in favour of the last.

Diagnosis.

Quite rightly, medical officers appear to send down every suspected case of the disease. The result is that we see a fair sample of the diseases with which it is most likely to be confused.

Of cases sent in with other diagnoses which subsequently turned out to be cerebrospinal meningitis, we have had : Two as (?) typhus ; one as typhoid ; one as erysipelas ; one as measles ; one as German measles. In each of these cases marked stiffness of the neck and Kernig's sign led to a puncture which at once settled the diagnosis.

Of fifty-two cases received at No. 7 with a diagnosis of cerebrospinal or (?) cerebrospinal, thirty turned out on further investigation to be suffering from other diseases.

These were in order of frequency :—

Trench fever	10
Influenza	3
Epilepsy	3
Pneumococcal meningitis	2
Lunacy	2
P.U.O. or febricula	2
Septic meningitis	1

Enteric	1
Paratyphoid B	1
Malignant endocarditis with meningismus ..	1
Uræmia meningismus	1
"Trench shin"	1
Trigeminal neuralgia	1
Appendicitis	1

The cases described as trench fever presented the following symptoms: Sudden onset, generally with vertigo, very rarely with vomiting. Severe pain in the legs and especially the shins, as a rule. Severe frontal headache at first, aggravated by rapid movement of, or pressure on the eyeballs. A variable temperature which might run to 103° F. or 104° F., generally falling to normal about the fourth day, and rising again four or five days later. Very often these subjective symptoms were surprisingly slight, e g., I have seen a trench fever patient with a temperature of 104° F. reading the papers and writing letters, and apparently none the worse for doing so. In one case there was slight neck rigidity, in another a fairly well marked Kernig's sign, while in a third both were distinctly present, though in all of them these signs were more "elastic" in character than in cases of cerebrospinal meningitis.

This was also the case in a man with the Paratyphoid B, who had slight pain and stiffness of the neck, and an "elastic" Kernig's sign with an angle of over 40°. In his case the very moderate character of the headache made one at once doubtful of the diagnosis, and his general appearance was suggestive of the typhoid group.

In one case of post-epileptic coma there was a marked neck stiffness and Kernig's sign, lumbar puncture, a normal temperature, and his history when he recovered consciousness, which he did after a few hours, cleared up the diagnosis.

The case of trigeminal neuralgia was interesting, as the slightest attempt at passive movement caused such pain as to set up a resistive stiffness, which simulated the stiff neck and Kernig's sign. None of the others call for special remark. If I may venture to sum up the points requiring the most attention if one is to avoid missing the important early diagnosis of the disease, I should suggest the following :—

(1) Every case of sudden onset of illness with vomiting should be regarded with suspicion until the diagnosis has been otherwise settled. This should especially be the case if a sore throat has preceded the illness within a week or two.

(2) Intensely severe headache, especially with vomiting, is highly suspicious.

(3) Kernig's sign and rigidity of the neck whether with or without vomiting are so suspicious that the diagnosis should at once be proved or disproved by a lumbar puncture.

Treatment.

The results of treatment of cerebrospinal in this epidemic are profoundly disappointing. In the statistics of 161 cases treated at S.H., published in the December number of the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, average mortality was fifty-two per cent. The sera of Flexner, Mulford, Burroughs and Wellcome, and Pasteur, as well as autogenous vaccines alive and dead were all tried. Allowing for the mathematically necessary margin of error in dealing with small groups of cases, none of these seem to have given results any better than those obtained from simple lumbar puncture. And our experience with a small number of cases so far brought to a termination at No. 7 has been no better.

Lumbar puncture certainly sometimes relieves the symptoms due to pressure, and probably in a few cases saves the life of a patient. But in some sooner or later only a few drops of fluid can be obtained. Presumably the foramina of the ventricles have become blocked, for symptoms of hydrocephalus follow, and at the post-mortem we find the ventricles distended with fluid. Various drugs have been tried—urotropine, citric acid, seamine; not one has proved itself of distinct value so far. But with the brilliant results obtained from America and in Belfast with Flexner's serum before us, we still hope to do better, as soon as a serum has been obtained from the strain of germs with which we are dealing.

Prognosis.

It is very difficult to make a prognosis. Certainly the temperature is of little value, as cases may do well who have run a long and severely febrile course. The pulse appears to me to be of more importance. Not one case under my care has recovered after a pulse of 200 has persisted for more than a few hours. The continuance of severe nervous symptoms such as a high Kernig's sign or incontinence also appears to be unfavourable. On the other hand, neither petechial rash, nor delirium are, so far as I can judge, necessarily alarming.

DISCUSSION.

Captain MCNEE, Officer in charge of the Mobile Laboratory, spoke of the cases he had seen: they were much earlier diagnosed, both before and at field ambulances and also at casualty clearing stations.

From February to December sixty-two positive cases were investigated by a mobile laboratory and also fifty-two lumbar punctures done with negative results. Of the sixty-two at least twenty died at the Front and so were not seen lower down the line. That type of case would, therefore, not be seen by the previous speaker. Number of cases was: February, seventeen; March, nine; April, eleven; May, eleven; June six, and in the rest of the year not more than eight.

He put *vomiting* without a definite cause as one of the most valuable symptoms and mentioned the other symptoms and signs.

Re the *Rash.*—All his cases were seen within forty-eight hours of going sick, the rash present in twenty per cent, most marked in those that died immediately, practically the majority of these having a rash. The most marked rashes he had seen were in three cases occurring in one platoon within forty-eight hours of one another, two dying within twenty-four hours, the third was sent down the line. The purple spots extended from the toes to the forehead.

With regard to unusual forms of the disease, one case was found comatose without having shown any previous signs. Two cases were sent in as acute maniacs, both died; the cerebrospinal fluid was clear in both cases, the meningitis was cerebral, the spinal cords normal. One brain looked like meningitis following middle-ear disease, the parietal region being coated with a thick deposit of lymph.

The differential diagnosis is from the typhoid and paratyphoid groups, typhus and meningismus; here there is headache, stiffness of the neck, Kernig's sign, rarely vomiting. On doing lumbar puncture the cerebrospinal fluid was found clear and not under high pressure, lymphocytes only being present, not polymorphonuclear leucocytes as in cerebrospinal meningitis.

As regards the bacteriology in cerebrospinal meningitis the meningococcus is not an easy one to find, and if you get a case of meningitis and the cerebrospinal fluid does not show any organisms after prolonged search you may say it is a case of cerebrospinal meningitis. In the other two sorts of meningitis you always find plenty of organisms. He thought high pressure of the fluid a valuable sign, in early cases it was always high except where the fluid was purulent. A question he was often asked in the field by commanding officers and medical officers of battalions: "Is the disease likely to spread?" You can safely say *no.* With regard to contacts there is great controversy. Even in normal populations a certain number of throats show naso-pharyngeal infection. Only the throats of the immediate contacts need be examined.

The means by which the disease spreads is from nose to nose if there is an epidemic. As a rule a very small percentage of the people are susceptible, hence the isolated cases. When a case occurs the immediate contacts should be isolated, the A.D.M.S. of the Division wires to the laboratory and they are examined; if, after isolation for three to four days the report is negative, there is no reason why the man should not go to duty forthwith, but a very good rule was laid down by Sir William Leishman, viz., that even if the result is negative the immediate contacts ought to be isolated at once and for a week. No cases have occurred due to the liberation of these contacts. Of 400 immediate contacts examined only three remained permanent carriers and were sent down. Of those found

negative, a second swab later also gave a negative result. Such cases may at once be liberated.

The methods and means of detection from a throat swab are difficult and three days must elapse before a diagnosis can be made. He emphasized the method of doing lumbar puncture by going through the middle line.

Lieutenant-Colonel Soltau said that his experience was practically limited to cases in civil life, as very few cases had come under his observation during the War. He mentioned the probability of nasal catarrh being a predisposing factor, as the largest case incidence occurred during the catarrhal period, and he quoted the report by Shearer on the remarkably enriched growth of the meningococcus on media to which a little sterilized nasal mucus had been added.

He asked as to the condition of the optic disks in the cases treated and thought that within twenty-four hours a definite papillitis was usually present and that at the end of forty-eight hours the optic cup was usually obliterated.

Of the seventy cases or so which he had seen he only remembered one in which a text-book rash was present and he was glad of the warning statement by the first speaker, that a rash was not an essential sign of the disease. He thought that its presence usually indicated a very severe infection, practically a bacteræmia, leading to hæmolysis. Another point he should like to hear discussed was that of cranial nerve involvement, as many cases showed this, and especially of the eighth nerve, leading to great deafness. The extreme and rapid emaciation was a further feature of the disease.

Dealing with diagnosis, the diseases liable to be confused were the meningismus of early typhoid or paratyphoid, that were occasionally seen with influenza, the severer forms of trench fever or pyrexia of unknown origin, and the meningitis associated with middle-ear disease. In the speaker's opinion the crux of the diagnosis lay in the spinal rigidity, associated with Kernig's sign. It was disappointing to learn that little reliance could be placed on Babinski's sign.

The question of treatment in the front line resolved itself into one of rapid removal. He thought, however, that considering the statement that patients showed bad effects as a result of the moving, a preliminary lumbar puncture should always be done in field ambulances. This would relieve pressure and probably minimize the prejudicial effects of travelling.

The disappointing feature in the paper was to learn that sera and vaccines had been of such small value. Having disposed of a case of cerebrospinal meningitis the vexed question of contacts remained. The segregation in large numbers was to be deprecated, as the presence of one carrier might mean many uninfected contacts becoming carriers. In the treatment of carriers the use of any vigorous measures of prophylaxis

should be avoided, as strong douches, etc., would be more likely to increase a nasal catarrh by setting up small local traumata, and so to increase the growth of the cocci. He would like to ask Captain McNee what the cases he had described as resembling the specific disease were, and suggested that the lymphocytosis in the cerebrospinal fluid might indicate an influenzal meningitis.

Lieutenant H. R. Brown in reply said he had not examined the optic disks, but an ophthalmic surgeon had arranged to do so in future. Of the twenty-seven cases only two showed deafness. As to Babinski's sign it was variable. One case of hæmorrhagic rash seemed to be recovering, his temperature having been normal for ten days. His treatment was first lumbar puncture. Then the bacteriologist suggested putting some of the man's own blood serum into his spinal cord; twenty cubic centimetres was injected. The man was very ill after the large dose but now is better. The suggestion of preliminary lumbar puncture at the front is a good one. A case of high pressure in the spinal cord is not necessarily cerebrospinal meningitis.

Colonel Skinner said that in order to prevent cases arriving in a collapsed condition at hospital plenty of blankets and hot water bottles ought to be provided for the journey. Concise notes ought to be sent with each case. An important matter is the period of segregation of contacts and he considered the seven days' rule a good one; also that only the immediate contacts of a case ought to be segregated. It is wasteful to segregate a barnful of fifty or more men.

Clinical and other Notes.

EXAMINATION OF FIFTY DYSENTERY CONVALESCENTS FOR CARRIERS.

By Temporary Captains J. A. ARKWRIGHT and W. YORKE,
Royal Army Medical Corps,

and

Temporary Lieutenants O. H. PRIESTLEY and W. GILMORE,
Royal Army Medical Corps.

The fifty men examined had all suffered from dysentery contracted on service and with one exception gave a history of passing blood and slime for periods varying from three days to nine weeks. In four cases a history was also obtained of an illness resembling enteric fever. The convalescents were not selected, but were the first fifty examinations completed in the course of search for carriers in a convalescent camp.

The date of onset of the original illness ranged from May, 1915, to January, 1916, but all except two cases first showed symptoms of dysentery before the end of November, 1915.

The examination began on February 16 and ended on March 24, 1916.

In every case, therefore, except two, the illness began more than two months before the investigation here recorded. The examination of fæces was made in each case on three occasions, an interval of two or three, or occasionally more, days elapsing between the separate observations. The specimens of fæces reached the laboratory within half an hour of being passed. The examination consisted of: (1) Microscopic search for protozoa; (2) plating on MacConkey's neutral red bile-salt lactose agar, and subsequent examination of colourless colonies by means of carbohydrate media and agglutinating sera; (3) a specimen of blood was taken from each man on one occasion and its agglutinating power tested against stock emulsions.

Results from Microscopic and Cultural Examination of Fæces.

The following tables give the results obtained by microscopic examination and culture:—

Entamœba histolytica was found in	9 men.
E. coli was found in	25 ,,
Lamblia intestinalis was found in	15 ,,
Bacillus dysenteriæ (Shiga) was found in	2 ,,
,, ,, (Y) was found in	0 ,,
B. typhosus B, *Paratyphosus* A or B in	0 ,,
Negative results (neither protozoa nor bacteria)	14 ,,

Trichomonas intestinalis was noted in two cases, but was not looked for, especially on account of the need for rapid work. In all the cases

in which *Entamœba histolytica* was recognized *tetragena* cysts were observed, and large or small vegetative forms were also observed in some of these.

A further analysis of the results of the microscopic examination shows that:—

E. histolytica was found alone in	.. .. ..	6 men
Entamœba coli ,, ,,	.. .. ..	12 ,,
Lamblia intestinalis ,,	.. .. ..	4 ,,
E. histolytica and *Lamblia* were found in	.. ..	1 ,,
,, ,, *E. coli* ,, ,,	.. ..	2 ,,
,, ,, *Trichomonas* were found in	.. ..	1 ,,
Negative	.. ..	14 ,,

In both cases from which *Bacillus dysenteriæ* (Shiga) was isolated, *E. coli* was also found, and in one of them *Lamblia* in addition. From the above statement it is seen that eleven (22 per cent) men out of the fifty convalescents were found to be carriers of pathogenic micro-organisms [nine *E. histolytica*, two *B. dysenteriæ* (Shiga)]. . . . The specimens from the same man did not always yield the same result on each of the three examinations—

In 2 men *Entamœba histolytica* was found on	..	3 occasions
,, 6 ,, ,, ,, ,, ,,	..	2 ,,
,, 1 man ,, ,, ,, ,,	..	1 ,,
,, 1 ,, *Bacillus dysenteriæ* (Shiga) ,,	..	2 ,,
,, 1 ,, ,, ,, ,, ,,	..	1 ,,

A single examination in each case therefore would not have given so many positive results, and it is reasonable to suppose that more numerous examinations would have revealed additional carriers.

Results of Agglutination Tests with the Serum of Convalescents.

Agglutination tests were made with the serum of each man against *B. typhosus*, *B. paratyphosus* A and B, *B. dysenteriæ* (Shiga and Y) and also against *Micrococcus melitensis*.

Definite agglutination with a dilution of 1 in 100 was regarded as a positive result in the case of *B. typhosus*, and *B. paratyphosus* A and B, and *B. dysenteriæ* (Y). A dilution of 1 in 50 was considered sufficient in the case of *B. dysenteriæ* (Shiga) and 1 in 400 was the only dilution used with the *M. melitensis* emulsion.

The method used was macroscopic and the reading was made after four hours at 37° C. and about eighteen hours at room temperature. All the men had been inoculated with *B. typhosus* vaccine and in twenty-seven a positive agglutination reaction was obtained with *B. typhosus*. Seven had also received a mixed *B. paratyphosus* A and B vaccine. Agglutination of these bacilli was explicable by the inoculation in these cases and the results have therefore been discarded.

In all the men negative agglutination results were obtained, against *B. dysenteriæ* (Y) and *M. melitensis.*

A positive result was obtained with *B. dysenteriæ* (Shiga) in twenty-one cases, including the two men from whom this bacillus was isolated.

A positive result with *B. paratyphosus* B was obtained in four cases, but in no instance was a positive reaction obtained with *B. paratyphosus* A (leaving out of account the men who had received paratyphoid vaccine).

MULTIPLE INFECTIONS.

Indications of multiple infection were given in six convalescents when the agglutination results were taken into consideration in addition to the microscopic and cultural results.

The serum of one man gave a positive reaction with *B. dysenteriæ* (Shiga) and with *B. paratyphosus* B.

The serum of one carrier of *E. histolytica* gave a positive reaction with *B. dysenteriæ* (Shiga) and with *B. paratyphosus* B.

The serum of three other carriers of *E. histolytica* gave positive reactions with *B. dysenteriæ* (Shiga).

The serum of one other carrier of *E. histolytica* gave a positive reaction with *B. paratyphosus* B.

An attempt to diagnose the original illness or illnesses from which the convalescents had suffered by agglutination tests rests on much less secure ground than diagnoses based on microscopic cultural evidence. However, an opinion may be formed of the numerical relation of the different kinds of infections.

From all the evidence obtained it appeared that :—

4	men	had	suffered	from	infection	with	*Entamœba histolytica* alone.
1	man	,,	,,	,,	,,	,,	*E. histolytica* and *B. dysenteriæ* (Shiga) and *B. paratyphosus* B.
3	men	,,	,,	,,	,,	,,	*E. histolytica* and *B. dysenteriæ* (Shiga).
1	man	,,	,,	,,	,,	,,	*B. dysenteriæ* (Shiga) and *B. paratyphosus* B.
16	men	,,	,,	,,	,,	,,	*B. dysenteriæ* (Shiga) alone (including two cases in which *B. dysenteriæ* was isolated).

For the remaining men no direct evidence was obtained as to the nature of the infection, but since they gave negative agglutination results there is, perhaps, a presumption that the majority had been infected with *E. histolytica.*

MAIN CONCLUSIONS.

Among fifty dysentery convalescents examined, three to six months after the onset of their illness, nine were still excreting *E. histolytica.* Two were still excreting *B. dysenteriæ* (Shiga). These eleven men were therefore potential sources for the outbreak of fresh epidemics.

A SIMPLE GREASE TRAP FOR CAMPS.

By Acting-Serjeant H. J. DAVEY.
Royal Army Medical Corps.

The accompanying diagram shows a simple grease trap easy to construct from materials available in all camps. It has proved efficient in actual practice, and has been in use for some time.

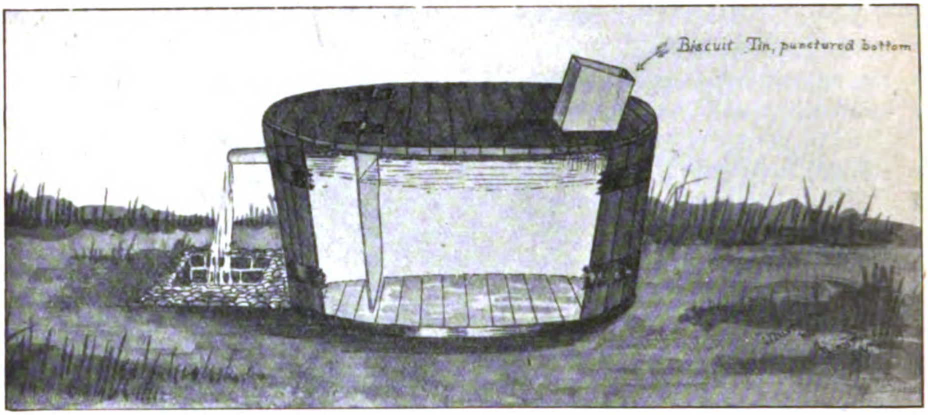


Fig. 1.

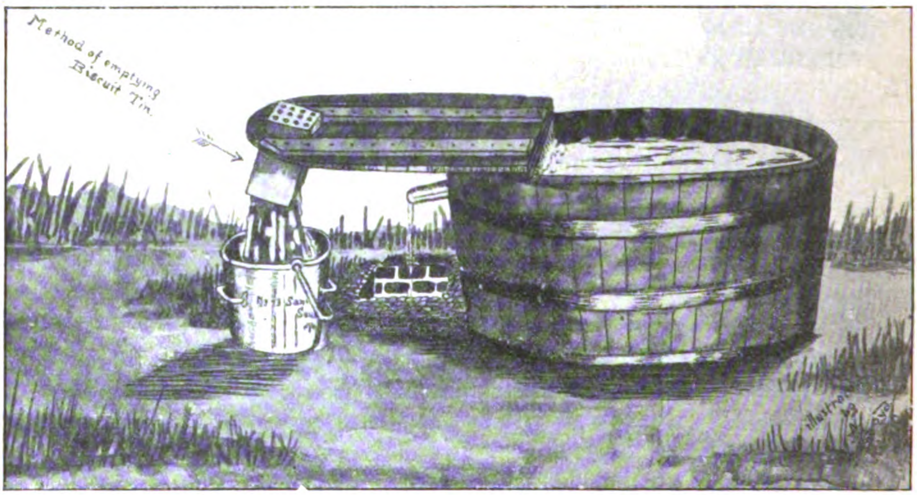


Fig. 2.

The materials required are half a wine barrel or stout box (preferably tin lined), wood for cover, wire or leather for hinges, and jam or biscuit tins.

Construct traps as follows: Take half a barrel (or box) and cut a hole five inches from the top and fit in jam tins as spout. Nail on a cover over one-third of the barrel covering the spout. Hammer out flat a biscuit tin, and use it as a vertical partition, nailing it to the cover already in position and to the sides to within four inches of the bottom of the barrel. Fix on the remaining two-thirds of the cover as a hinged lid. In this lid fix an open biscuit tin with perforated bottom. The tin should slope from the centre as shown in the diagram. This enables all debris to be emptied into a pail réceptacle when the hinged lid is thrown open.

Fill up the barrel and trap with water, and place hay or straw in the biscuit tin to arrest solid matter. The trap drains into a soak pit or open drain, if possible.

The kitchen water, grease and debris from the cookhouse are emptied into the biscuit tin, solids are arrested, emptied as necessary and burnt. The grease accumulates on the surface water on the open side of the trap and is periodically skimmed off and burnt.

The trap attends to itself and requires only the supervision and cleaning inseparable from all improvised sanitary contrivances.

DESCRIPTION OF A SPLINT FOR A FRACTURED HUMERUS.

By Captain COLIN MACKENZIE.
Royal Army Medical Corps.

The splint which I am about to describe is one which should be of practical use in a casualty clearing station.

There it is of great importance that one should be able to dress any compound fracture of the humerus immediately prior to evacuation, without anæsthesia, but with the minimum of pain to the patient. This is possible if the limb remains fixed, and the splint is not moved during the dressing.

As the "Page" splint has proved so useful for cases of fractured femur, I have modified it so that it may be applied to the arm. It is obvious that if the fixed point of the upper end of the splint was against the axilla, there would be the possibility of pressure on the vessels, a state of affairs very undesirable where the wound may be already infected with gas-forming organisms.

The fixed point of the upper end of the splint is above the shoulder and is maintained in contact with the acromial process by two straps, one of which passes round the chest below the opposite axilla from the top of the splint, and the other from the same point on the splint to a belt round the waist of the patient. The chief difficulty in making the splint was the weakness of the shoulder portion. This was remedied by making the upper part of the splint with one piece of standard aluminium

splinting, and I am indebted to Serjt.-Major Scott Badcock, R.A.M.C., for the suggestion of the curve over the anterior aspect of the shoulder which I shall describe later. Staff-Serjt. Lee, R.A.M.C., made various models on these lines and I am greatly indebted to him for the interest and trouble he took in making them.

I will now briefly describe the method of making the splint from the standard aluminium splinting.

The enclosed diagram drawn by Pte. Reynolds, R.A.M.C., and the photographs taken by Captain McNee, R.A.M.C. (S.R.), will render the method easier to understand.

To make the Upper Half of the Splint (see diagram).—Take a full length of aluminium splinting (twenty rings).

(1) Bend on the *edge* at the middle point (X in figs. 1 and 2) to a right angle.

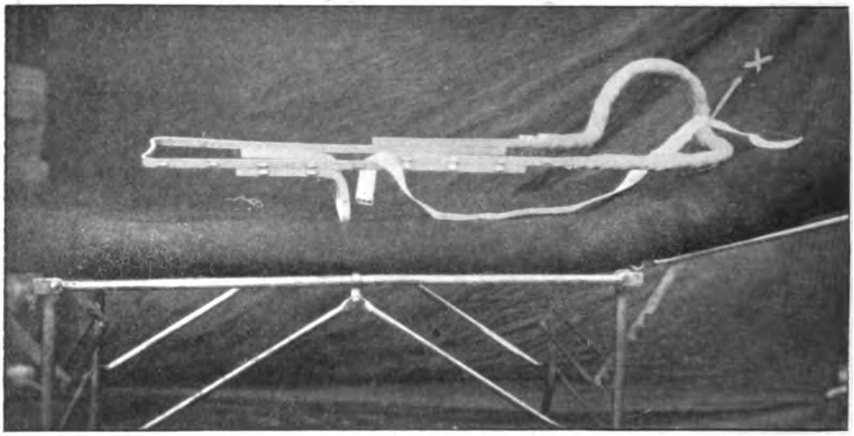


FIG. 1.—Shows the completed splint. The point for attachment of the two straps for fixation is shown x.

(2) If it is desired to make a splint for the left arm, bend on the *flat* the first six-ring length of the right-handed limb, holding the splinting with the angle towards you and the rings uppermost in a semicircle directed upwards, so that the sixth ring is on the same plane as the left-handed limb.

(3) Now twist the remaining four-ring length portion of the right limb with pincers through a right angle so that its *edge* is now in the same plane as the *flat* of the semicircular portion (fig. 3).

(4) Bend on the *flat* in a gentle curve the first six-ring portion of the left limb so that the lower four-ring portion is opposite the lower four-ring portion of the right limb. The upper portion is now completed,

except for padding round the curved parts. If the splint is required for the right arm, in the above description substitute left for right, and vice versa in the above description in steps two, three and four.

To make the Lower Half of the Splint.—Take a seventeen-ring length of the splinting and bend on the *flat* at right angles just above the eighth ring. Bend again on the *flat* at right angles just beyond the ninth ring. The result is a " U "-shaped half (which should have the rings external). A step should be mounted to this half as in the lower portion of a Page splint.

The two portions are assembled in exactly the same method as the Page splint, three or four rings being bolted together, according to the length of arm of the patient. The step should look in the opposite direction to the semicircular portion of the upper part of the splint. Fig. 1 shows a splint for the left arm completed.

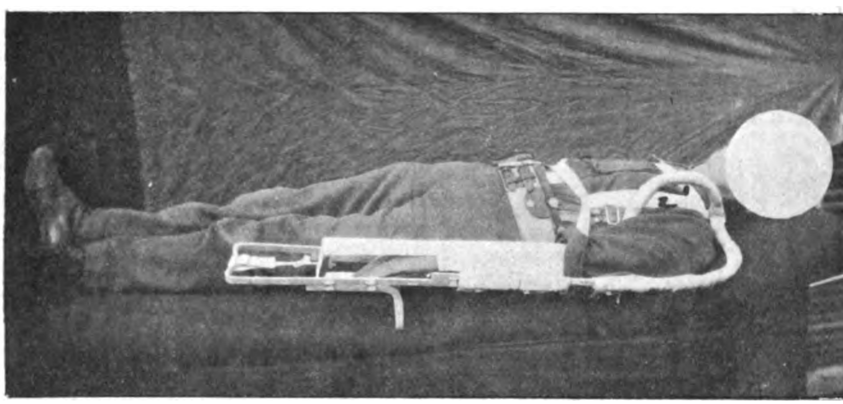


FIG. 2.—Shows the splint applied. Note the straps 1 and 2 which secure fixation of the point x.

Method of Application.—It is better applied when the patient is under an anæsthetic, as when the wound is cleaned and dressed for the first time at a Clearing Station, although it can be applied without an anæsthetic, and without causing very much pain. The arm is held in the extended position by traction of the forearm, and slipped through the splint which is held so that the semicircular portion is anterior and internal to the limb. This semicircular portion is now brought to be over the anterior aspect of the shoulder, and so that the extended arm lies between and in the same plane as the straight bars of the splint.

The splint is fastened by a strap which passes round the chest (below the opposite axilla) from the point X on the diagram; this point is also fixed by a strap to a strap round the waist of the patient.

The arm is kept in a state of moderate extension by fixing the wrist to

the distal end of the splint by means of a flannel bandage, or a stirrup made with Mead's strapping.

Strips of flannel or perforated zinc passed beneath the arm and fore-arm from one side of the splint to the other form a support for the limb.

Fig. 2 shows the splint applied to the left arm.

Advantages of the Splint.—(1) It is easily made and applied.

(2) It ensures fixation of the limb without pressure from the splint on either the limb or on the vessels of the axilla.

(3) If the lower end of the splint be supported, the patient can turn on his side without pain, thus facilitating dressing of other wounds and nursing.

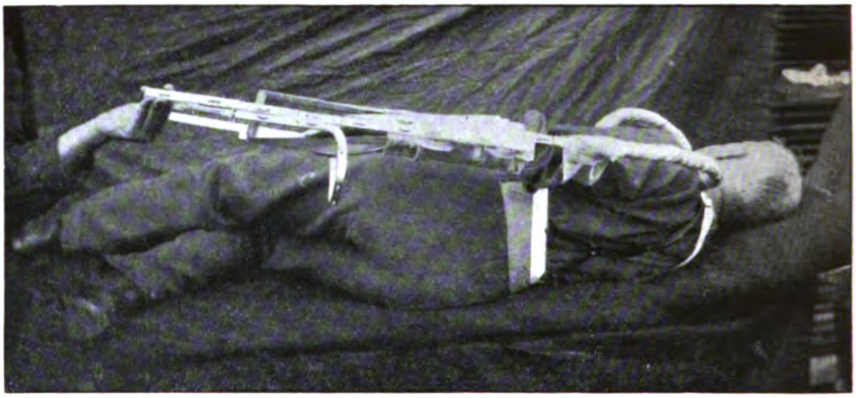


FIG. 3.—Shows how, if the end of the splint be supported, the patient can turn on his side if other wounds require dressing.

The relative position of the arm to the patient can be changed if he so desires, and the arm may be freely abducted for purposes of dressing as shown in fig. 3.

(4) The wound can be dressed without removal of the splint.

(5) The maintenance of moderate extension ensures free drainage. Possibly the aluminium splinting will not prove sufficiently strong to stand the journey to the base and a splint of this nature made of malleable wire will prove more suitable.

Some are now being made, though for purposes of dressing the flexibility of aluminium splinting renders access to the wound easier.

TREATMENT OF SEPTIC WOUNDS WITH GLYCERINE AND ICHTHYOL.

By Captain G. G. ALDERSON.
Royal Army Medical Corps.

At a Divisional rest station in France, where practically all the operations were of the type carried out in the surgical out-patient department of a civil hospital, namely, the opening of superficial abscesses, it was decided, after reading Major Duggan's articles in the Journal of the Royal Army Medical Corps, to try dressing these cases with glycerine and ichthyol instead of boracic fomentations. At first a twenty per cent, but later a 10 per cent solution, spread on ordinary white lint, was used, and later for purposes of economy commercial glycerine was substituted for pure glycerine. Fifty-nine cases were thus treated after operating under an anæsthetic, besides many others of which no record was kept, and in which no anæsthetic was necessary. They included carbuncles, whitlows of all types, and three cases of cellulitis, two of the upper and one of the lower limb. In favour of this treatment are the following points :—

(1) Saving of labour and material—one application daily being substituted for three boracic fomentations.

(2) Efficiency as a dressing. In several of the cases previously treated with boracic foments, the discharge was never more in twenty-four hours on the one glycerine and ichthyol dressing than on any one of the fomentations, though these had been changed twice and thrice daily.

(3) The dressing does not adhere to the wound.

(4) Men voluntarily told the nursing orderlies that they found the ichthyol dressing more soothing.

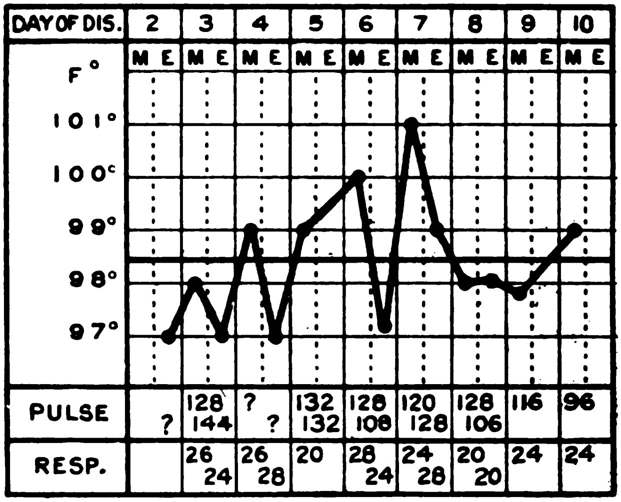
This treatment is therefore recommended to medical officers, civil and military, for use in dressing superficial septic sores and wounds, as being: (*a*) equally efficacious; (*b*) more economical, as regards time and material, than the boracic fomentation.

A CASE OF GAS GANGRENE EXHIBITING UNUSUAL PROOFS OF A BLOOD INFECTION.

By Captain G. T. MULLALLY, F.R.C.S.Eng.
and
Captain J. W. McNEE, M.D.
Royal Army Medical Corps.

This case is reported because it presented, in an unusual and convincing way, proofs of the occurrence of a blood infection with gas-forming organisms. No similar case has occurred in our considerable experience of gas gangrene, nor have we heard of any other like it. The essential facts may be given at once.

Private ——, Argyll and Sutherland Highlanders, was wounded in the right arm on March 18, 1916, and admitted to a Casualty Clearing Station next day. When admitted he was in a state of profound collapse, and almost pulseless. The bullet had entered the back of the right upper arm, and emerged in front and to the inner side, making a large ragged wound. The humerus was fractured, and the brachial artery torn across. Anti-tetanic serum had been injected at a Field Ambulance before admission. On the following day he was rather better, and the wound was thoroughly syringed out with peroxide solution. Towards evening he collapsed again, and became almost pulseless. The wound was dressed, and at this time showed no definite evidence of gangrene. Although somewhat delirious, he now began to complain of pain in the left pectoral region, where the anti-tetanic injection had been given. Next morning a little crackling was felt over this area, but this was at first put down to air having perhaps been injected along with the serum. Owing to the collapse, he was given during the



night a hypodermic injection of pituitrin into the left forearm. On March 21 his general condition was unchanged, but a large patch of gas gangrene was now evident on the inner side of the right arm and forearm, below the exit wound. Another patch of gangrene was also found on the left side of the chest, including the area of the anti-tetanic injection. Both gangrenous areas were freely incised, and dressed with peroxide solution. The affected area on the chest wall included skin and subcutaneous tissue only, the structures below the deep fascia not being invaded. On March 22 he was not so well, and a further patch of gas gangrene had appeared on the outer side of the left forearm, where the pituitrin had been injected. This new area was incised, and treated as in the other cases. Cultures from all three wounds, and also from the blood, were made on this day (*vide infra*).

He now began to improve, in spite of a certain amount of spread of the gangrenous condition on the left chest into the axilla, which necessitated further incisions. The right arm was amputated above the wound on March 24, after

which the man made a good recovery, being strong enough to be evacuated to the Base on the 27.

The following are the details of the bacteriological examination.

Films were made from all three wounds, and stained by Gram's method. In all the films bacilli of malignant œdema type, showing central spores, were recognized, along with a variety of other organisms. Cultures were made from all three wounds and from the blood, in the following media :—

(1) Shake cultures in large tubes of glucose agar.

(2) Broth cultures made partly anaerobic by placing a wad of cotton wool, soaked in a mixture of pyrogallic acid and caustic soda, in the tube below the rubber stopper.

By both of these methods growth was readily obtained of an organism, which later showed central spores, and was morphologically identical with the bacillus of malignant œdema. The same organism was obtained in the cultures from all the wounds, and from the blood as well. As regards the blood, five cubic centimetres of which was used to inoculate the tubes, the broth culture yielded the better result. In all the glucose agar tubes inoculated there was marked production of gas, splitting up the medium.

We are indebted to Major H. Rogers, R.A.M.C., for permission to to record this case.

A USEFUL KNEE SPLINT FOR CASES REQUIRING COMPLETE ARTHROTOMY.

By Captain H. H. HEPBURN.
Royal Army Medical Corps.

In the treatment of severe infected wounds of the knee-joint, complete arthrotomy has been found necessary in many cases. The post-operative treatment and the nursing of these patients is difficult, to say the least. The chief difficulties are found in maintaining the limb in a fixed and comfortable position, and at the same time providing for the care of the patient's back and the normal action of the bowels. A splint which will not admit of comfortable change of position predisposes to constipation and makes pressure sores a constant danger.

I have used for these cases a splint which meets with the approval of the surgeon, the nursing staff, and the patient. The accompanying photographs are published with the hope that they may be of service to others in the treatment of such cases. The aluminium material and the required tools are found in the Royal Army Medical Corps Field Fracture Box. Fig. 1 is a photograph of a splint used on a man of average height and no variations are required except for a very large or small man. The angle of the back strip should be approximately forty-five degrees. The gutter should be deep enough to receive about three-quarters of the circumference of the leg and thigh. No further measurements are

necessary as the number of staple arches can be counted in the photograph. A small pad is placed in the popliteal space of the splint, then the leg and thigh parts are padded, leaving the region of the knee-joint

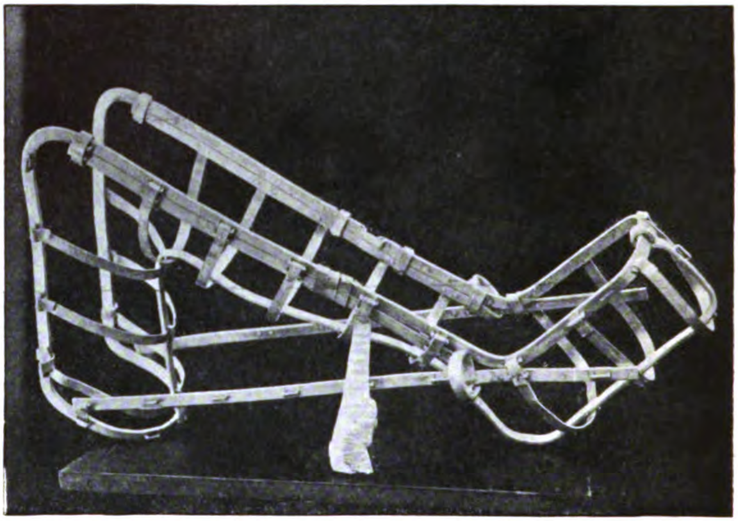


FIG. 1.

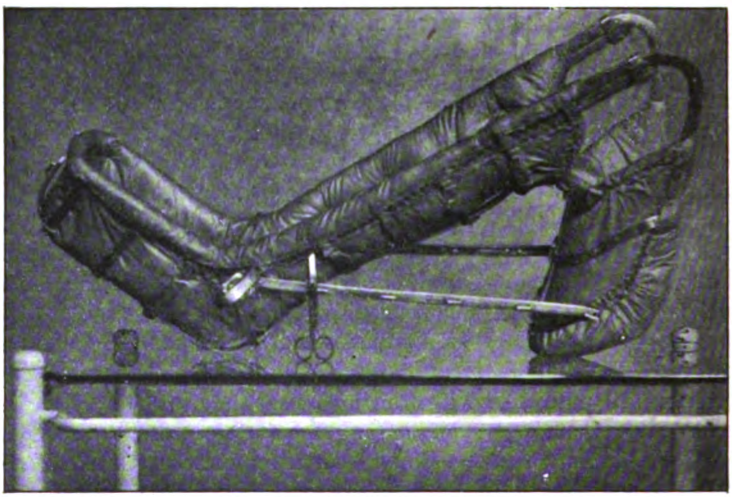


FIG. 2.

open to allow for dressings as in fig. 2. It is advisable to cover the entire padding with jaconet.

When applied, the splint is easily moulded to fit the leg and thigh,

and, if firmly bandaged, the knee-joint is securely fixed. The patient will lie comfortably on his back or on either side with the limb supported on pillows, or suspended by cords from the knee and ankle to a cradle or Balkan frame.

This splint need not be removed until the joint has cleaned up, and the limb is ready to be straightened out and placed on an ordinary dorsal splint.

A SUGGESTED LATRINE SYSTEM FOR THE USE OF TROOPS IN THE FIELD, ON L. OF C., AND AT THE BASE.

By Captain K. P. MACKENZIE.
Royal Army Medical Corps.
(*With Diagrams.*)

To those interested in the sanitation of camps, etc., the accompanying "System of Latrinage" may prove of use.

The main points in its favour are:—

(1) No ground soiled, or used up in any way.

(2) No chloride of lime necessary.

(3) Absolute exclusion of flies (i.e.) a "sealed system."

(4) Urine and fæces never mix, nor come in contact with each other (i.e.) a "separator system."

(5) Portable method and can be used at any time.

(6) Minimum of paper used.

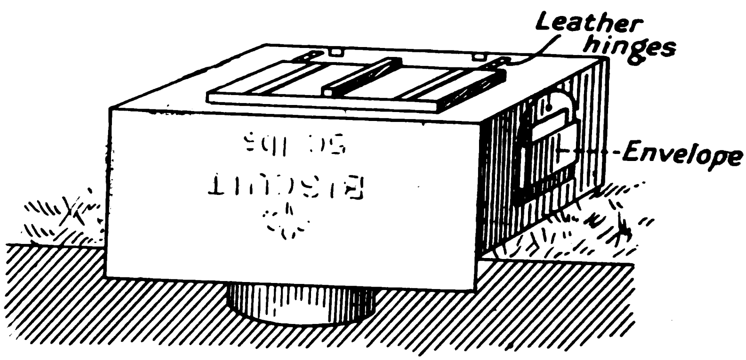
(7) So far as known it is the only system in use that at the same time combines the above points.

(8) It is a system specially suitable for universal use, is capable of being used in the open or in buildings, on active service, and in standing camps in time of peace.

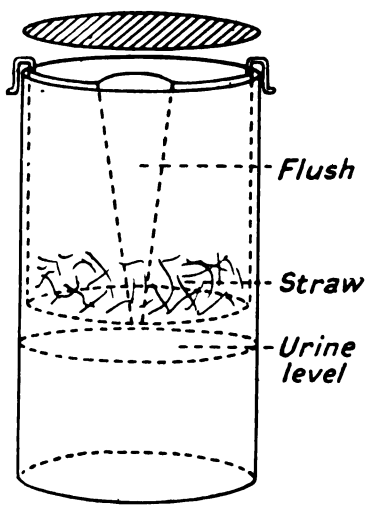
This system has been specially designed to comprise a certain number of *sine qua nons*. It is as simple as possible and is comfortable and convenient, even on active service. It is easily and quickly made of easily procurable materials and is easy to comprehend by even the dullest Thomas Atkins.

It affords the sanitary men on duty the easiest and most accessible means of disposing of excreta. There is a minimum risk of soiling the hands or ground, and within limits the system is unoffending and cleanly and capable of meeting all contingencies of weather, and needs a minimum sanitary staff.

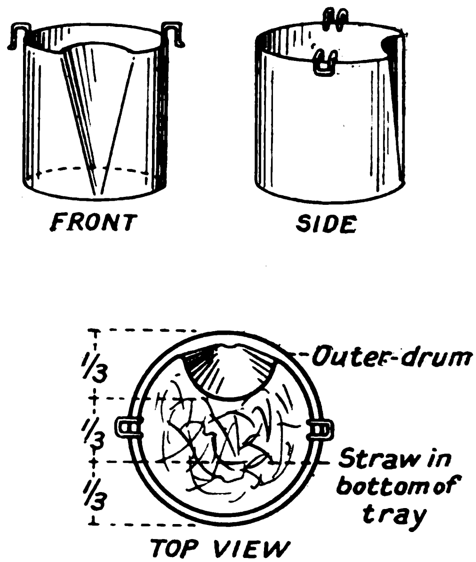
Materials required.—(*a*) An empty wooden ration biscuit box for preference, or other box complete with lid, or a thick square piece of wood (two or three inches thick) with a circular opening in it to serve as a seat, and an automatically closing lid to cover whole; (*b*) an empty



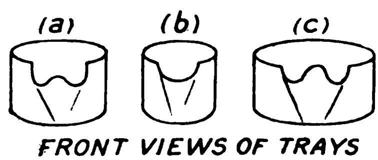
The Apparatus Complete.



Without Box. Section through Top Rim of Drum, showing Tray in situ.



Tray



six-gallon drum (lubricating oil); (*c*) two empty five-gallon cresol drums; (*d*) a small piece of thin wire.

Construction.—The box is utilized to serve as a seat and a circular opening of suitable size is cut out of one side. The diameter of the opening is about one inch less than that of cresol drum. Two reinforcing bars of wood may be nailed on the inner aspect of this opening, so far apart as to permit of the oil drum brim fitting between them. This prevents lateral movement of seat.

A lid is made from the opposite side of the box of such a size as to cover the greater part of the seat (to prevent its getting wet in rainy weather); it is hinged on by leather or other hinges and should be so fitted as to drop automatically over the seat.

The top of the six-gallon drum is cut out and any rugosities of the brim filed down.

The seat rests on this brim and thus prevents access of flies from without. Two "V" shaped notches are cut on each side of the drum diametrically opposite, 2 inches apart and ¼ inch deep, i.e., just sufficient to admit the wire handles of the inner drum.

The two cresol drums are cut in half or a little deeper. The top parts are discarded and bottom parts are used to serve as inner or fæces trays which are slung by means of wire handles.

The cresol drums are of a special form. A part of the side is bent in, so that the upper brim presents a "reniform" instead of a circular outline (as in fig.). From the brim to the bottom of the tin this part, which is bent in by thumb or hammer, is moulded to form what is called the "urine flush," as it is down the outer side of this tin that the urine passes to the drum beneath.

Two wire handles are made for each inner drum and should fit exactly into notches cut in the outer or urine drum.

The large drum (six-gallon) is now placed on the ground (it need not be dug into the ground) and one of the cresol trays slung inside it and the seat with lid, or box with lid, placed on top.

Two tin envelopes made from an empty biscuit or petrol tin, of such a size as to hold only Army Form O.O. or paper cut a similar size, are attached to the sides of the box.

These prevent paper blowing about, and by a special over-lapping tongue prevents its getting wet. Four such can be made from any petrol tin or biscuit tin and can be cut by scissors.

The cresol tray or fæces tray should fit the posterior half of the outer or urine drum very closely and should be slung so as to be not more than 2 inches to 2½ inches from the level of the brim of the outer drum.

Straw, dry leaves, sawdust, paper or oil may be placed in the bottom of the fæces drum.

A few drops of pure cresol solution are placed in the bottom of the urine or outer drum.

Two mops of sacking or cloth should be always at hand with a little cresol solution for cleansing the drums and trays.

Two trays should be made for each latrine, and when one set is in use the other should be stacked in one corner of the latrine ready to replace the first trays when these are full.

A list of directions may be placed in the latrine, but is not necessary, viz.:—

(1) See that lid always covers the seat on leaving.

(2) The stream of urine should be so directed as to pass down the flush of the tray into the drum beneath.

(3) Only toilet paper to fit the envelopes on the side of seat should be used.

(4) Any offence will be severely dealt with.

The trays for fæces according to depth will be sufficient for 15, 20, 30, 40 or 60 successive users. Those cut a little deeper than half the depth of cresol drum answer best as they pack inside the drum when moving camp.

Several kinds of seats may be made, but all should have a "lid" whether made from boxes or not.

Various kinds of trays have been made and experimented with, some deeper, some shallower, some with perforated bottoms and no urine "flush"; some with angular bottoms, but these latter were not so satisfactory to use.

When oil and cresol drums are not available, empty biscuit tins and petrol and desiccated vegetable tins may be used instead. It will be found that the petrol tins and vegetable tins fit inside the biscuit tins, but do not stand so high off the ground and are not so durable nor water-tight as the drums, also instead of working with circular receptacles, one works with square and angular ones.

Disposal.—Fæces trays may be emptied into an incinerator in convenient quantities so that continual incineration is established, or the full tray may be suspended till completely incinerated by its handles on a transverse rod let into the incinerator.

Urine in the outer drum is emptied into a urine absorption pit.

This system has been in continuous use in several places since February last, and has given the utmost satisfaction.

Lecture.

INJURIES OF THE EYE AND ORBIT.[1]

By Captain ARTHUR D. GRIFFITH, M.B., B.S.Lond.; F.R.C.S.Eng.
Royal Army Medical Corps (Territorial Force).
Officer in Charge, Military Hospital, Hamrun, Malta; Specialist in Ophthalmology, Malta Command; Surgeon, Royal Eye Hospital, London.

Gentlemen,—I feel that I owe you an apology for inviting your attention to a speciality. My justification must be that ophthalmology is the speciality which, more than others, presents grave problems in war; problems on the correct solution of which depend the future happiness and usefulness of the patient. Injuries of the eye and orbit form a comparatively small proportion of the cases with which the oculist has to deal. Analysing 350 consecutive cases from active service from my note-books, I find that twenty-five per cent are cases of injury, and fifteen per cent cases of a condition which is a rarity in peace practice, and which may be called "Shock Amblyopia." I shall refer to this condition in detail later. Of the remainder, the majority (forty per cent) are cases of error of refraction, including squint, and the remaining twenty per cent include such diverse conditions as conjunctivitis, pterygium, conical cornea, old injuries, retinitis pigmentosa, tobacco amblyopia, nuclear ophthalmoplegia, injuries to the visual cerebral cortex, and many others.

The cases of eye injury fall easily into two classes—those in which little damage has been done, and useful vision will be retained, and those in which the eye is at once utterly spoiled, with a very small intermediate class. A more useful classification, however, is the anatomical.

Cornea.

Cases in which the cornea alone is injured are those of foreign body in the cornea, and traumatic ulcers. As to ulcer, I shall say nothing, except to register a protest against the use of cocaine in this condition. It is pleasant to be able to give one's patient an application which at once relieves his pain; but cocaine softens the corneal epithelium, and renders it susceptible to the attacks of micro-organisms, so that the use of this drug in cases in which the forces of destruction and repair are evenly balanced may decide that the forces of destruction shall prevail, and thus cause the spread of the ulcer, and seal the fate of the eye.

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[1] A lecture delivered at the University of Malta, before the Conference of Medical Officers, Malta Command, January 14, 1916.

Foreign bodies in the cornea may be superficial, as are the majority, lying in the corneal epithelium or penetrating the substantia propria for a short distance, or may be buried in the substantia propria, or may be so deep as to project into the anterior chamber.

When superficial, they are readily picked out with the point of a cataract needle, or, if that be not available, the operation may quite well be performed with a sewing needle or even the point of a penknife. In performing it, it is well to remember that the object is to remove the foreign body, and not to remove corneal tissue, and when a small particle is neatly removed it should be impossible to see the wound. For removing a foreign body buried in the substantia propria of the cornea, there are two methods available. One method is to dig away corneal tissue until the particle is exposed. This is easy, but it is clumsy, and leaves a crater which must be filled, in part at any rate, by scar tissue, which is opaque. The better method is to cut a flap of corneal tissue just so thick that when it is lifted up the particle is exposed and can be picked out with the point of a needle. The flap then falls back in place, and the resulting scar is minimal.

With the very deep foreign bodies, there is the risk that the most gentle manipulations may force the particle through the cornea into the anterior chamber, where it will be a grave menace to the eye, and whence it will be very difficult to remove. The removal of these foreign bodies may be one of the most difficult operations in ophthalmic surgery, and should only be undertaken under the best conditions.

As illustrations of the methods which may be employed, I will quote two cases:—

Pte. A. V. S., aged 19. On September 1, 1916, near C— Hill, S—, a bomb burst in his trench, and he sustained many superficial wounds. There was a small foreign body nearly at the mid-point of the right cornea. It was very deep, resting on Descemet's membrane, but not projecting into the anterior chamber. Under cocaine anæsthesia, a bent broad needle was passed into the anterior chamber, and its point was made to support the foreign body from behind, while a cataract needle, working from the front of the cornea, removed it.

Pte. T. J. H., aged 22. On September 18, 1915, at A—, a bullet struck the sandbag parapet, and sand was flung into his left eye. There was a transparent foreign body (flint) the size of a pin's head, projecting into the anterior chamber. Under cocaine anæsthesia, the anterior chamber was opened by a bent broad needle at the corneo-scleral junction, and a small sharp spoon was passed in behind the foreign body. Counter-pressure was applied to the front of the cornea by means of a curette, and the foreign body was removed in the spoon.

Iris.

The two affections of the iris which concern us are iridodialysis, and wound at the periphery of the anterior chamber with prolapse of the iris.

Iridodialysis, or rupture of the base of the iris, occurs as a result of a blow on the eye, or of the passage of a foreign body through the iris. Iridodialysis is recognized, even when the basal rupture is small, by the flattening of the corresponding portion of the pupillary margin. In the cases of non-penetrating injury, the condition is chiefly important by reason of the hæmorrhage into the vitreous which usually accompanies it. Vitreous hæmorrhage, as seen in cases from active service, is too extensive to hope for the degree of recovery that one expects to see in civil practice, and the patients cannot, before reaching a base hospital, have the complete quiet that is desirable. The end of these eyes is that when the hæmorrhage absorbs it leaves a more or less coarse web of opacity in the vitreous which greatly impairs vision. Wounds at the periphery of the anterior chamber, with prolapse of iris, require early and thorough attention.

The prolapsed iris should be seized, drawn out, and sheared off. It is essential that the iris be cleanly cut, and that so much be drawn out that the edges retract clear of the wound in the cornea. Unless these points be observed, the cut edges will adhere to the scar, and the eye will remain irritable for a long time, and so long as it is irritable the eye cannot be regarded as safe. A second operation to free the adhesion will be difficult, and probably unsatisfactory.

Lens.

Traumatic cataract is practically always due to the passage of a foreign body through, or its retention in, the lens.

Careful examination will reveal a scar in the cornea, often very minute. The question arises—Is the foreign body in the lens, or has it passed through? If it is retained in the lens, there is a possibility that by extracting the lens one may remove the foreign body, and save a useful eye. Two examinations may assist one to determine this point; examination of the field of light, and localization of the foreign body by means of X-rays. The first examination is carried out by projecting a pencil of light, by means of a mirror, into the eye from various directions, the sound eye being covered. The patient is directed not to move his eye, and to point to the light. If he can indicate the direction from which the light is coming, promptly and accurately, and if his vision is at least equal to "Shadows," it is probable that the mischief extends no farther back than the lens. Localization by means of X-rays I shall refer to later.

One of the first patients received in Malta from the G. Peninsula was a case of lens injury.

Pte. R. M., 1/5th Royal Scots, was in the orginal landing, when something struck him in the left eye. He did not know what struck him as he was unconscious for about three hours. Since then the left eye had

been defective. I saw him on May 8, and found a scar at the corneo-scleral junction above. The corresponding segment of the iris was wanting; the lens was absent, and the pupil was occupied by opaque capsule, in which was a good central opening. The picture was precisely that of an eye on which a satisfactory cataract extraction had been performed. There was no other abnormality. I was too busy then to estimate his error of refraction, but with my + 13 ophthalmoscope he read the second hand of my watch, and I have no doubt that with a suitable lens his vision would have been perfect. It was evident that the blow had caused the rupture of the cornea and of the lens capsule, and driven the lens out of the eye.

Fundus.

Injuries of the retina, choroid and optic nerve I will only briefly mention. The series includes eight cases of detachment of the retina. This is produced by a comparatively light blow on the eye, or by concussion of the eye from the passage of a bullet in its neighbourhood. These cases all occurred in the first two months of the campaign. I am not hopeful of any benefit resulting from treatment in these cases. Similar injuries may produce hæmorrhage into the retina.

Concussion of the eye is also liable to produce a pigmentary degeneration of the retina, which especially affects the central macular region, and I have seen one case of the curious condition described as "hole at the macula." Rupture of the choroid is caused by similar injuries, and all these conditions may be found in the same eye. Atrophy of the optic nerve may be produced in several ways. The commonest method is for a blow in the neighbourhood of the orbit to produce a fracture which runs into the optic foramen. This may cause either rupture of the nerve, in which case blindness is instant, or its slow destruction by contraction of scar tissue or pressure of callus. In this type the only signs are the dilated pupil, inactive to direct light stimulus, and the atrophy of the disc. Secondly, a bullet traversing the orbit may divide the nerve. Thirdly, a bullet entering the orbit may so dislocate the eye as to rupture the nerve. In the last two cases the atrophy of the nerve will usually be associated with hæmorrhages in the neighbourhood of the nerve-head and other fundus lesions.

Blindness.

The series includes six cases of blindness. (I regard as "blind" any case in which the vision is reduced to perception of hand movements or less).

(1) An officer at A— Hospital. Both eyes were ruptured by a bullet passing transversely.

(2) An officer at S— Hospital. The right eye had been excised, on a hospital ship, for rupture; the left eye had almost total detachment of the retina. I was anxious that this officer should be given the slender

chance of regaining some vision by being kept flat for several weeks, rather than undergo the disturbance of transport and possible sea-sickness, but he was very anxious to get home, and he was sent to England.

(3) McC., at R— Hospital. The left eye had been excised for rupture; the right eye showed simple optic nerve atrophy, probably due to a fracture into the optic foramen.

(4) Pte. A. H. C., at A— Hospital. He had been struck on the left side of the face by fragments of a hand grenade. Both retinæ were detached.

(5) Pte. D. O., at H— Hospital. A bullet had traversed the back of both orbits, and both eyes were proptosed, blind, and disorganized.

(6) Pte. S. J. L., at H— Hospital. A similar condition, both orbits having been traversed by a bullet.

Shock Amblyopia.

Shock amblyopia or shock amaurosis is the name which may be applied to diminution or loss of vision following a shock in which no structural change is produced in the eye or optic nerve. The shock is usually from the explosion of a shell or grenade near the patient, and at first I called the condition "shell amblyopia," but it may be due to other causes; one case followed a kick on the head by a mule.

A typical history is that the patient was in a fire trench, and a shell burst a few yards away, and thereafter the sight in the one or both eyes was blurred.

The patient is usually knocked down by the explosion, but is often not unconscious. One can distinguish four conditions:—

(1) *Transient Blindness from Over-stimulation of the Retinæ.*—In this condition the patient sees a flash of light from the shell-burst, and afterwards sees only a grey or purple haze. This is an exaggeration of the normal exhaustion of the retinæ from exposure to light. It is usually recovered from completely, but one sometimes finds fine degenerative changes at the macula, such as one is familiar with in "electric ophthalmia" and "eclipse amblyopia."

(2) *Blindness from Closure of the Lids.*—In this condition the over-stimulated retinæ are hyperæsthetic, and the patient endeavours to protect them from light by a vigorous blepharospasm. If the lids are forcibly opened the vision is found to be little affected. The photophobia may be recovered from in a few days, or may persist for months.

(3) *True Amblyopia.*—There appears to be two types of this condition. In one the loss of vision is partial, and the recovery is steady and gradual. In the other type there is usually total blindness of one or both eyes, which remains unaltered for a time, and is recovered from either rapidly or instantaneously. Some cases of the latter type have been treated with success by suggestion.

In one such case of one-sided amaurosis I put the sound eye under

the influence of atropine, and found that the patient continued to read books with his blind eye, although he averred, and firmly believed, that he could not distinguish light from dark with it. Some days later I examined his vision at the test types, and found that his vision in the good eye, under atropine, was $\frac{6}{18}$. (There was a low degree of hypermetropia.) Covering the good eye the vision was "no perception of light." I then uncovered both eyes und placed before the good eye a plus lens sufficiently high to fog it completely. The vision with both eyes was still $\frac{6}{18}$. I succeeded in demonstrating the fallacy to the patient, and he then read $\frac{6}{18}$ with his previously blind eye. He was even more pleased with this result than I, and I am convinced that he was not malingering. I then omitted the atropine, and it was interesting to note that as the vision in the atropinized eye improved, the vision in the amblyopic eye improved, until both were normal.

(4) In a few of these cases an eye which formerly could see perfectly without a glass now requires a plus lens to bring the vision to the normal. The explanation of these cases must be that of a hypermetropia which formerly was overcome by an effort of accommodation, and so latent, has become manifest. This would appear to be a muscular asthenia localized to the ciliary muscle.

From a consideration of the cases in which the defect is unequal in the two eyes, one may arrive at the following conclusions:—

(1) If the shell burst to one side of the patient, the eye on that side is likely to be more affected.

(2) If one eye was struck by a fragment of shell or earth, that eye is likely to be more affected.

(3) If one eye had a greater error of refraction than its fellow, it is more likely to be affected. Allied to this condition are the cases of cured squint recurring after an explosion.

Wounds of the Globe.

Wounds of the globe present the most important, and the most difficult, problems, because in dealing with them we have to face the possibility of the occurrence of sympathetic inflammation. This is a cyclitis occurring in an eye as a result of a wound of its fellow. It is tolerably certain that sympathetic cyclitis is never caused by a non-penetrating injury. In connexion with wounds of the globe one has to answer the question "Is this eye a danger to its fellow?" If it is decided that an eye is dangerous, it should be removed as early as possible. Although sympathetic trouble never develops within ten days of the injury, and rarely within three weeks, a considerable portion of this period of grace has already elapsed by the time the patient arrives in Malta. It is impossible to dogmatize on this subject, but it is helpful to remember that two conditions which are especially liable to lead to sympathetic cyclitis are wounds in the ciliary region, and wounded eyes which are shrinking.

Although it has never been proved, it is extremely likely that sympathetic cyclitis is due to a micro-organism, presumably one which has a special liking for uveal tissue. If this be so, it is easy to understand that the chief consideration in deciding whether an eye is dangerous or not is whether it is inflamed or quiet.

In certain groups of cases the decision to remove the injured eye, or to spare it, is easy to make. In this connexion I may quote two cases of somewhat similar injuries.

Cpl. W., R.M.L.I., under the care of Fleet Surgeon Bishop at the R— N— Hospital, B—.

On April 25, 1915, he was struck in the face by several fragments of a hand grenade. Fleet Surgeon Bishop removed a splinter of steel, one inch in length, from the right outer canthus. I examined the fundus, and found a clean wound of retina and choroid behind the equator, in a position corresponding to that of the foreign body. The vision was $\frac{6}{8}$, the eye was quiet, and there was no doubt that it was a sound eye.

Pte. R. H., 1/9th Battalion, Manchester Regiment. On October 18, 1915, a hand grenade exploded near him and he was struck in the left eye. He went to the field ambulance, where a spicule of metal was removed from the eye. The medical officer sent him to the base with some excellent notes, and a letter in which he expressed the hope that the eye might be saved. I saw him on November 12, and found a scar, concentric with the limbus and six millimetres from it. The vision was reduced to perception of light, the tension was ·3, and the eye was irritable. There was, in this case, not the least doubt that the eye was dangerous, and should be removed. If one eye is ruptured it should be removed. If both eyes are ruptured, as a rule they should be left. There is no question of further damage from sympathetic trouble, and it is kinder to allow a blind man slowly to realize the calamity which has befallen him, than to convert the faint hope of some return of vision, which he cherishes, into the awful certainty of blindness by removing the ruins of his eyes. If a wounded eye is blind, it should be removed. If a wounded eye has poor vision, and is irritable, especially if it is soft, and still more, if it is tender, it should be removed. If a wounded eye has good vision, but is irritable, it should be watched, and given an opportunity to quiet, the period allowed bearing some relation to the degree of vision it possesses.

In border-line cases, where one is in doubt whether to spare the eye or to remove it, the tendency should be to remove the eye. I would rather remove many damaged eyes unnecessarily than allow one patient to become blind through my fault. I have already indicated that, in watching a doubtful case, the appearance of fresh, or the non-subsidence of existing signs of inflammation, are indications for removing the eye. With regard to the sound eye, the signs to look for, especially, are

photophobia, lachrymation, and circum-corneal injection. These constitute the clinical picture of "sympathetic irritation." This is not an early stage of sympathetic cyclitis, and may, indeed, be produced by so common and trifling an accident as the lodgment of a foreign body under the upper lid, but it is an indication that all is not well with the other eye, and is, therefore, a most valuable danger signal. An examination which should always be made of the sound eye, when its fellow is on probation, is the measurement of the shortest distance at which the eye can read small type. If this "near point" is found to recede, it indicates paresis of accommodation, and this is often the earliest sign of sympathetic cyclitis.

Except that it may carry micro-organisms, a foreign body does not, in itself, cause sympathetic trouble, but if it be retained, there is the added factor of the irritation due to its presence, and it is reasonable to suppose that this may determine that a small dose of organisms, which the eye might otherwise dispose of, may be enabled to establish themselves. From this point of view, it is important to know whether a wounded eye contains a foreign body. In some cases it is possible to see the foreign body on ophthalmoscopic examination; in the majority, it is necessary to employ localization by means of X-rays. The most satisfactory method of localizing metallic particles in the eye by X-rays is to make a stereoscopic pair of pictures, and to estimate the position of the foreign body in relation to a known body, which is in some known relation to the eye, by measuring the relative displacements of the shadows of known and foreign bodies.

(Here followed a description of the apparatus used.)

Whatever method is adopted, it is essential that meticulous care be taken over all measurements and adjustments. Above all, it is necessary that the patient does not move his eye during the examination.

A retained foreign body having been demonstrated, it must be decided whether the eye will tolerate its presence or not. The degree of irritability of the eye (circum-corneal injection, photophobia, lachrymation), and the amount of inflammatory reaction in the neighbourhood of the particle, if it can be seen, assist in the decision. If the foreign body cannot be seen, the examination of the field of light is of assistance. As a rule, the farther back in the eye, the better is a foreign body tolerated, and one fixed in the retina is better tolerated than one in the vitreous.

If it be decided that the particle will not be tolerated, the alternatives are removal of the particle, and removal of the eye. It is unfortunate that the majority of metallic foreign bodies met with in war injuries are composed of lead, so that they cannot be removed by the electro-magnet, which is the only method which gives at all satisfactory results. On the other hand, lead is less soluble, and less irritating than iron, and is

therefore better tolerated. Iron particles retained in the eye, even if tolerated for a time, usually cause its eventual degeneration.

Trpr. R. P. M., 5th A.L.H. On September 24, 1915, at A—, he was looking through a loophole in a steel shield, and a bullet splashed on the margin of the loophole, and he was struck in the right eye. On October 9 the vision in the eye was $\frac{6}{12}$. There was slight circum-corneal injection. There were scars at the periphery of the cornea and the iris. X-ray examination indicated that there was a flake of metal, triangular in shape, measuring 1 millimetre by 1 millimetre, 19 millimetres behind, 6 millimetres external to, and 7 millimetres below the central point of the cornea. The pupil was then dilated and the foreign body was seen, embedded in the retina, at the point indicated by the X-ray examination. There was then no inflammatory reaction in the retina, although a little pigmentation appeared later. Two months after the injury the eye was perfectly quiet, and the vision in the injured eye was $\frac{6}{9}$.

Pte. B. H. F., 10th Battalion, A.I.F. On July 30, 1915, at A—, a grenade struck his bayonet and exploded. The right orbit contained numerous foreign bodies; one in the eye. Vision-fingers at one metre, eye irritable. Attempted removal; evisceration done. (Foreign body was a fragment of lead.)

The subject of sympathetic cyclitis is a very difficult one, and when everything has been said about it, the thing which most impresses me is the maxim that "One good eye is better than two bad ones."

If it is decided to remove an eye there are two ways of doing this—by excision, and by some form of evisceration. In removing an eye which is dangerous from the point of view of sympathetic cyclitis, the object is to remove the uveal tract, which is the source of infection. This is done with certainty by excising the globe, and it is sometimes wise to do this. The disadvantages of this operation are that there is some risk (a small one, I think) of infecting the meninges from a septic conjunctiva, and that the stump resulting does not well support an artificial eye. The old operation of evisceration consists in making a stab incision into the globe just behind the ciliary zone, that is, about seven millimetres from the obvious corneo-scleral junction, completing a circular incision through all the coats of the eye with scissors, and turning out the contents of the sclera. After this operation healing is sometimes delayed, because the cut edge of the sclera is exposed. Also if the stump is sutured there is often a pretty severe reaction. To obviate these defects, an operation has been devised which consists in dissecting conjunctiva, Tenon's capsule, and muscles off the globe, removing the cornea, turning out the contents of the sclera, and then cutting away the sclera except for a small frill around the optic nerve.

This is probably the safest operation, but it has still the disadvantage of leaving a poor stump.

If the old operation be compared to the "no flap" circular amputation which has been performed on war injuries of the limbs, the operation just described may be compared to an amputation with a long flap, and almost no stump. The operation which I have been performing in the majority of these cases is an amputation of the anterior part of the eye, leaving the longest stump, which can be covered by the flap of conjunctiva.

Conjunctiva and Tenon's capsule are divided circularly, going behind any wound if possible, otherwise excising it. These membranes are turned back as a cuff for at least one centimetre, and the anterior part of the eye amputated at this level, or farther back if that is rendered necessary by a scleral wound. The contents of the sclera are turned out and every trace of choroid removed by means of gauze mops held in pressure forceps. If the conjunctival sac is clean the conjunctiva is closed by three sutures. If it is thought desirable to drain the cavity, this is done by a wisp of gauze, and a long suture inserted in the conjunctiva, which is tied at the end of twenty-four hours, when the drain is omitted. Healing occurs in about five days, there is no reaction, and a good movable stump results.

An operation which has some place in war ophthalmology is exenteration of the orbit. This consists in removing the whole of the contents of the orbit except the periosteum. The object is to provide the fullest possible drainage for the orbit. I have done this in two cases.

Pte. J. R., Otago Battalion, N.Z.E.F. On August 8, 1915, he was struck in the right eye by a rifle bullet. On August 10, on a hospital ship, the eye was excised. He was admitted to H— Hospital on August 16. The wound of entry was at the root of the nose; the wound of exit was in the right temple, one inch behind the external angular process of the frontal bone. The lids were greatly swollen and the orbital contents were very sloughy. Next day his temperature was 103·4° F., and on examining the orbit there was what appeared to be gangrenous brain at the apex. This was an error of observation, as this proved to be sloughy ocular muscles. Exenteration was performed, and it was found that, in addition to the exit hole in the outer wall of the orbit, there were fractures of the roof, floor and inner wall.

The subsequent history is of interest. The orbit remained perfectly clean and the temperature settled, but eleven days after the operation there was a rigor, with the temperature rising to 105° F., and the right side of the head was œdematous. Next day the œdema was more marked and there was tenderness over the jugular vein on that side. A diagnosis of thrombosis of the cavernous sinus was made, and the question of performing a craniectomy was discussed. I decided to wait for another rigor, but this did not occur, and the condition cleared up. At a later date the cavity was covered with Thiersch's skin grafts, and a soundly-healed socket resulted.

Pte. E. H., 7th Battalion Royal Munster Fusiliers. On August 17, 1915, he was lying in the open, firing, and a grenade exploded close to his right side. He was admitted to H— Hospital on August 27. There was a large irregular wound of entry at the middle of the right supra-orbital margin; no wound of exit. The right eye was blind, much proptosed, and practically immobile. The conjunctiva was chemosed below.

X-ray examination showed two large foreign bodies, one in the orbit, behind the eye, and the other in the frontal sinus. The orbit was exenterated, and the frontal sinus, which was in communication with the orbit and had dura mater exposed in its posterior wall, was freely opened and drained into the orbit. The subsequent progress was uneventful.

When the bullet entering the orbit traverses the brain, the orbital condition is, of course, of minor importance.

The slides show the brain of a patient who was struck by a rifle bullet at the inner side of the right orbit. The bullet left the orbit at its apex, where there was a large hole in the sphenoid, traversed the brain, and made its exit above the right ear. The patient died on the day after admission.

Reference has already been made to the injuries to the optic nerve and retina produced by the passage of a bullet through the orbit, and the slides show typical fundus pictures of the lesions produced.

I will quote three cases of foreign body lodged in the orbit in which the eye was spared.

Of these, the first was under the care of Colonel Charters Symonds, to whom I am indebted for permission to quote it. The other two were under my care at H—.

Pte. G. M., 5th Battalion Wiltshire Regiment. On August 15, 1915, he was struck in the right side of the face by a rifle bullet. There was a wound of entry ½ inch behind the right malar bone; no exit. The patient complained of nothing until two days later, when the left eyelids swelled.

On August 28, there was marked proptosis of the left eye, with moderate chemosis of the conjunctiva. The upper lid was much swollen. The ocular movements were much restricted in all directions except down. There was diplopia in all directions. The pupil and fundus were normal. No accurate estimation of the vision was made, but this seemed to be perfect. In the succeeding days, the proptosis increased, and there was much pain.

On September 2, Colonel Symonds exposed the outer wall of the orbit in the left temporal fossa, and opened it with a chisel. On incising the orbital periosteum, the point of the bullet was seen, and it was readily removed. The wound was drained, and except for the drainage opening, healed primarily. After the operation, the eye at once receded,

and three weeks later, the ocular movements were nearly normal, and there was little diplopia.

Trpr. C. W., Otago Mounted Rifles, N.Z.E.F. On August 9, 1915, he was struck by a rifle bullet in the right side of the head. He was admitted to H— Hospital on August 16. There was a wound of entry in the right temple, 2¼ inches behind the external angular process of the frontal bone, and two inches above the zygoma. No exit wound.

There was a slight proptosis, and slight chemosis of the conjunctiva below. The lower lid was swollen and tender. There was diplopia to the right and below.

X-ray examination showed the bullet lying obliquely on the floor of the orbit.

On August 26, the orbit was opened through an incision along the infraorbital margin, and the bullet found halfway back on the floor of the orbit, and readily removed. Recovery was uninterrupted, and two months later the ocular movements were perfect, there was no diplopia, and the vision had improved to $\frac{6}{9}$.

Lance-Cpl. A. V. B., 27th Battalion, A.I.F. On October 7, 1915, he was in a fire-trench when a shrapnel shell burst overhead, and he was struck by a ball. He was admitted to H— Hospital on October 13. There was a wound of entrance at the nasion; no exit wound. The left eye was blind and much proptosed, and there was a great deal of chemosis. The eye was directed up and a little out, and almost immobile.

X-ray examination showed a shrapnel ball far back in the orbit in its inner wall. In the next ten days the conjunctiva became cleaner, and the proptosis diminished.

On October 23, an incision was made through the conjunctiva on the inner side of the eye, and the inner wall of the orbit exposed. A large fragment of loose bone was removed, and on full retraction of the eye, the ball was seen lying in a cavity in the posterior part of the ethmoid, and removed. No sutures were used. The wound healed rapidly, and some vertical movement of the eye was regained. The diagram shows the fundus condition. There was simple atrophy of the optic nerve, several hæmorrhages in the neighbourhood of the disk, and a large triangular area of atrophy of retina and choroid to the inner side, where these coats were bruised by the ball.

His left eye, although blind, is better than an artificial eye.

Review.

LOCALIZATION BY X-RAYS AND STEREOSCOPY. By Sir James Mackenzie Davidson, M.B., C.M. London: H. K. Lewis and Co., Ltd. Pp. xi and 72, with 26 stereoscopic plates. Royal 8vo. Price 7s. 6d. net.

In writing a book upon any scientific subject there are two methods open to the author. One of them is to view the work in all its aspects and to give the opinions and practice of various workers without expressing any very definite opinion as to which of these methods is the one most favoured by the author. This method is apt to lead to the production of a large volume which is placed upon the library shelf and referred to chiefly when information is desired on various means of approaching the subject in hand. To set out to read such a book deliberately from cover to cover is rather like taking up an encyclopædia for a similar purpose, in fact it is practically an encyclopædia on the subject.

The second method is to give a clear exposition of the author's own opinions and technique with the briefest of references to other workers in the same field. By this means a small, concise, handy and practical book is produced, and it is the method adopted by Sir James Mackenzie Davidson in his work on "Localization by X-rays and Stereoscopy."

The chief essential for such a book is that the author shall be thoroughly conversant with his subject, and the work of Sir James in this connexion is too well known for there to be any doubt on that score.

The book is practical, concise, interesting to the point of fascination, and packed with condensed information from title-page to index. Whilst there are certain statements in it which will not gain universal acceptance by radiologists, there can be no doubt as to the clear and forceful presentation of the author's views. It is particularly useful, too, in that it appears at a time when the problem of localizing foreign bodies within the tissues is exercising the minds of the profession to an abnormally high degree.

Perhaps the outstanding feature of the book is the number of clever experiments and the clear manner in which they are described and explained. The reader will soon discover this for himself, since the third page of the book gives a simple and reliable method of testing the sharpness of focus of the cathode stream, and hence the fineness of definition of which an X-ray bulb is capable. This point is of great practical import, as a coarse focus point cannot give good definition and a tube with too fine a focus will be short-lived. Several very interesting pinhole photographs of the actual focus spot are given and the means of obtaining them described.

Consideration is next devoted to the secondary rays evolved from the walls of the tube. The presence of these rays and the fact that they are actually evolved from the tube wall is demonstrated by simple but convincing experiments, and the danger of these secondary rays to the operator amply insisted on.

In speaking of the improved definition resulting from the use of diaphragms to absorb the secondary rays and in stating that such diaphragms should be placed close to the tube, no mention is made of the risk of tube perforation if the diaphragm is not electrically connected to earth, resulting from electrostatic induction in such a large mass of metal. This accident has been of frequent occurrence owing to neglect of this simple precaution, and due attention should be given to the point, especially since the manipulation of X-ray apparatus is now in the hands of so many men who are not thoroughly accustomed to its use. Even with the diaphragm "earthed" it must not be allowed to be too near the tube, or the potential differences which exist between them when the tube is working will cause a spark to pass and perforation of the tube to occur.

Protective appliances are discussed, but are worthy of more detailed mention. To the radiologist who already knows how to supervise his own means of protection this section is not necessary, and for the beginner it is not sufficient. No indication is given as to what thickness of protective material has been found necessary, and no information is afforded as to rough tests by which grossly deficient so-called protection can be detected. To work with "protection" which does not protect is to live in a fool's paradise and is almost certain to lead to very serious consequences. The addition of a few simple tests which could easily be applied would greatly enhance the value of this section.

The principles and value of stereoscopic radiography, in ordinary work as well as in localization, are clearly set forth and are made easily intelligible by means of excellent illustrations. The majority of the illustrations are stereoscopic and gain in value accordingly.

Many radiologists will not agree with the statement that stereoscopic work is easier with the tube beneath the couch, but it is an exposition of the method adopted by the author as well as by many other workers and, as such, is correspondingly valuable. Detailed descriptions of the apparatus and of its manipulation are given in such a manner as should instruct the veriest tyro.

In the actual process of localization, Sir James has wisely confined himself to the method with which his own name is so intimately associated. As befits the subject which gives the volume its title, this matter is very fully dealt with, both theoretically and practically. Several applications of the same principle are given and mention is made not only of localization by radiography but also by radioscopy. In connexion with the latter method, further warning might be given that it is this branch of the work which is most likely to damage the operator unless his means of protection are very ample. In the opinion of many men this method tends to be less accurate than when plates are used and it has also the disadvantage of not leaving a permanent record for reference. It is, in addition, more than possible by screen methods of localization to miss small fragments altogether if they are situated in thick portions of the body, and further, even though the fragment may be accurately localized, bone damage may not be seen unless a plate be taken in addition. The presence or absence of bone injury, even in a minor degree, may influence prognosis and treatment to such an extent that diagnosis from screen examination alone seems scarcely justifiable. It may be sufficient merely to ascertain whether there be a large foreign

body or gross bone damage, but cannot pretend to give a full and exact diagnosis such as is possible by radiographic methods.

A most important branch of the subject is the precise localization of metallic particles in the orbit and very detailed information is given of the procedure, an illustrative case showing the great value of extreme precision with reference to a decision as to whether an eye should be enucleated or not.

Brief mention is made in appendices of the telephone probe and the alternating electro-magnet as aids to localization; of the suppression or use of the inverse current and the author's own experiments thereon, and finally, the rules drawn up by the Röntgen Society for the protection of X-ray operators are given.

The volume is well printed and the illustrations are excellent, though some of them at the end of the book appear to have lost in reproduction.

As the author himself states, the book is not for one who is totally unacquainted with X-rays, it is for the worker who can take an ordinary radiograph and wishes to become proficient in localization, and for such a man it can be recommended with confidence. More advanced workers will also find in it much food for thought and may take the experiments as models.

H. Martin Berry.

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C.N. = Clinical and other Notes.
C.L. = Current Literature.

JOURNAL

OF THE

ROYAL ARMY MEDICAL CORPS.

Corps News.

July, 1916.

EXTRACT FROM THE "LONDON GAZETTE" OF FRIDAY, MAY 19, 1916.

Whitehall,
May 16, 1916.

The King has been graciously pleased to award the Decoration of the Albert Medal to the undermentioned Non-commissioned Officer and man of His Majesty's Forces in recognition of their gallantry in saving life:—

ALBERT MEDAL OF THE SECOND CLASS.

Cpl. James Webb, Royal Army Medical Corps.
Dvr. Richard Foley, Royal Field Artillery.

On January 2, 1916, during a heavy bombardment, Webb and Foley, acting on their own initiative, left a place where they were safe, and ran out to bring two wounded French civilians into a dug-out. They got both men into a cellar. During this operation heavy shells were falling all around them, and a motor-cyclist, who was assisting to bring in the second man, was killed.

Military decorations could not be awarded in these cases, as the acts of gallantry were not performed in the face of the enemy.

His Majesty the King has been graciously pleased to approve of the appointment of the undermentioned Officer to be Companion of the Distinguished Service Order, in recognition of his gallantry and devotion to duty in the field:—

Temp. Capt. Thos. Lewis Ingram, R.A.M.C. (attached 1st Battalion, Shrops. L.I.).

For conspicuous gallantry and devotion to duty. He collected and attended to the wounded under very heavy fire, and set a splendid example. Since the commencement of the war he has been conspicuous on all occasions for his personal bravery.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers, in recognition of their gallantry and devotion to duty in the field:—

Capt. James Couper Brash, M.B., 10th Field Ambulance, Royal Army Medical Corps (Special Reserve.)

For conspicuous gallantry and devotion to duty. He went to an artillery dug-out which had received a direct hit, and, assisted by two men, extricated the wounded and administered first aid under heavy shell fire.

Capt. Henry Percival Hart, M.B., R.A.M.C.

For conspicuous gallantry and devotion to duty when, although himself wounded, he went out, dressed, and brought into safety the wounded under heavy shell fire.

Temp. Capt. Philip Randal Woodhouse, M.B., R.A.M.C. (attached 1st Battalion, Irish Guards).

For conspicuous gallantry and devotion to duty. He tended the wounded under heavy shell fire, and though himself wounded, continued his work. On another occasion he went across the open under shell fire to attend to the wounded.

Temp. Lieut. William John Knight, M.D., 73rd Field Ambulance, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty when in charge of an advanced dressing station under heavy shell fire. He continued to attend the wounded with great coolness.

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned man, for acts of gallantry and devotion to duty in the field:—

No. 11702 Pte. A. Hamilton, R.A.M.C. (attached 1st Battalion Shrops. L.I.).

For conspicuous gallantry and devotion to duty. During very heavy shell fire he tended thirty to forty wounded men lying in the open, bringing into safety as many as possible. He led stretcher parties to collect isolated cases, and set a fine example generally.

ARMY MEDICAL SERVICE.

Surg.-Gen. Sir William Babtie, V.C., K.C.M.G., C.B., M.B., K.H.S., to be a Director of Medical Services at the War Office, dated March 18, 1916.

Col. Roger Kirkpatrick, C.M.G., M.D., on completion of four years' service in his rank, is retained on the Active List, under the provisions of Arts. 120 and 522 Royal Warrant for Pay and Promotion, 1914, and to be supernumerary, dated May 21, 1916.

The undermentioned to be temporary Colonels whilst Assistant Directors of Medical Services:—

Dated December 31, 1915.—Bt.-Col. Frederick Smith, C.M.G., D.S.O.

Dated April 15, 1916.—Lieut.-Col. John Poe, D.S.O., M.B.

Dated April 28, 1916.—Lieut.-Col. Arthur W. N. Bowen.

Dated May 2, 1916.—Lieut.-Col. Robert J. Blackham, C.I.E., F.R.F.P.S.

ROYAL ARMY MEDICAL CORPS.

Lieut.-Col. Arthur L. A. Webb, C.M.G., to be a Deputy Assistant Director General, vice Lieut.-Col. H. P. W. Barrow, dated June 1, 1916.

Lieut.-Col. Charles T. Blackwell, M.D., is retained on the Active List, under the provisions of Arts. 120 and 522 Royal Warrant for Pay and Promotion, 1914, and to be supernumerary, dated May 31, 1916.

Qmr. and Hon. Capt. Richard Scott, R.A.M.C., to be Hon. Major, dated May 17, 1916.

The Rev. S. B. Pelling, C.F., attached — Cavalry Field Ambulance, writes:—

"Yet another laurel has been added to the athletic prowess of the Medical Services, for it has fallen to the lot of the — Cavalry Field Ambulance to win the very handsome silver Cup and Medals presented by General Kennedy and his staff for competition amongst all units of the — Cavalry Brigade.

Sixteen teams in all entered for the competition, which was played on the league system and extended over a period of seven months, though interrupted from time to time owing to the exigencies of Active Service.

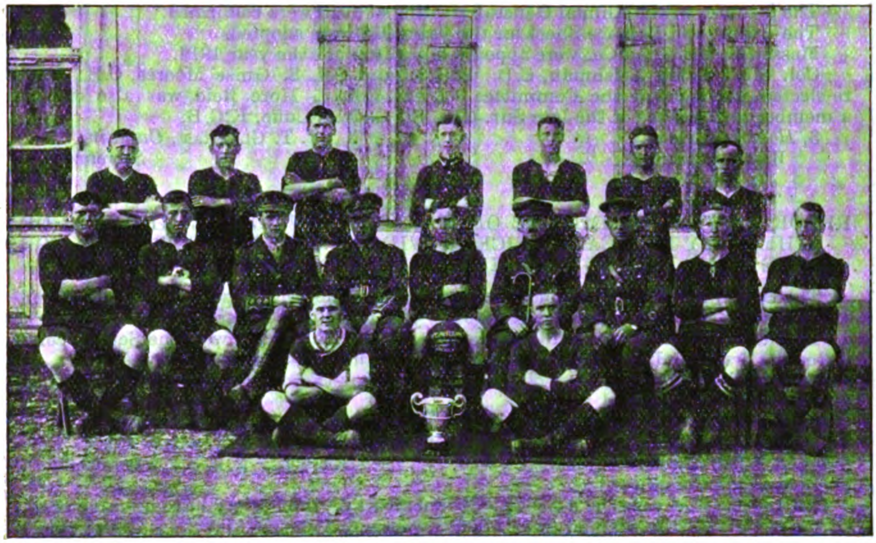
Of the fifteen matches played the — Cavalry Field Ambulance won twelve, lost one, and drew two, having a total of twenty-four points, the Battery being runners-up twenty-two points.

At a smoking concert given by the officers of the Ambulance, the Cup and Medals were presented by the Brigadier, who complimented the team on their very creditable performance.

Appended are the names of those who represented the — Cavalry Field Ambulance: Officer-in-command Lieut.-Col. H. Herrick, R.A.M.C. (now A.D.M.S.); President — Cavalry Field Ambulance Football Committee; Capt. A. N. R. McNeill, R.A.M.C. (now O.C., — C.F.A.).

Team—Goal: Cpl. G. F. Adkins (S.W.M.B.F.A.); Backs: Cpl. G. Snapes (A.S.C.), Cpl. E. Perry (W.B.M.B.F.A.); Half Backs: Drvr. W. L. Smith (S.M.M.B.F.A.), Pte. H. D. Dodd (W.B.M.B.F.A.), Cpl. H. J. Roden (S.W.M.B.F.A). ; Forwards: Rev. S. B. Pelling, C.F. (Captain), Drvr. R. Beattie (A.S.C.), Pte. T. Garrigan (R.A.M.C., S.R.), Pte. F. C. Mulley (R.A.M.C., N.A.), Drvr. M. Finnon (A.S.C.).

Reserves: Pte. F. E. Thomas (S.W.M.B.F.A.), Pte. R. Thomas (W.B.M.F.A.), Pte. A. James (S.W.M.B.F.A.).



THE ARMY MEDICAL OFFICERS' WIDOWS AND ORPHANS FUND.

Summary of Proceedings of Meetings of Members of this Society held at the Royal Army Medical College, on May 26, 1916; Surg.-Gen. M. W. Russell, C.B., Deputy Director-General, in the Chair.

SPECIAL GENERAL MEETING.

The Report of the Actuary on the Valuation of the liabilities of the Society as at December 31, 1915, was submitted to the Meeting which agreed with his view that under the circumstances mentioned in his Report the Society was justified in making special use of a portion of the large accumulation of surplus.

The recommendation of the Committee, as advised by the Actuary, that, under Rule X, provision of following *additional* benefits, be made out of the general surplus, involving in his opinion, a reserve for that purpose of about £7,000, was unanimously adopted:—

(1) An addition of 4 per cent to all annuity benefits, immediate or contingent, in respect of married members on the books at December 31, 1915, then entitled to annuity benefits of £50 per annum, making their annuities up to the statutory limit of £52 per annum.

(2) A sum of £100 to be paid at the death, *during this current Quinquennium*, of every first class married member (and widower subscribing, under Rule IX for orphan benefits), and of £50 in the same event in the case of every second class married

member on the books at December 31, 1915, to his widow, or orphans (under 21 years of age), by his present marriage.

[The effect of the adoption of recommendation (2) will be that, *for this current Quinquennium*, the death benefits will be £200 payable at the death of every first class married member who was on the books at December 31, 1910, and of £100 at the death of every married member who has joined the Society during the Quinquennium of 1911-1915. And pro rata for second class members.]

ANNUAL GENERAL MEETING. (101st).

The Minutes of the Annual General Meeting of 1915 were confirmed.

The Report and Balance Sheet for the year 1915 were adopted.

Messrs. Deloitte and Co. were appointed Auditors for the year 1916.

Col. Sir William Leishman, C.B., F.R.S., and Col. S. Guise Moores, C.B., were re-elected members of the Committee. Lieut.-Col. J. More Reid was also elected a member in the place of the late Sur.-Gen. Sir Charles Cuffe, K.C.B.

3, *Homefield Road, Wimbledon, S.W.*

J. T. CLAPHAM, *Captain, Secretary.*

REPORT OF THE COMMITTEE OF MANAGEMENT TO THE MEMBERS OF THE ARMY MEDICAL OFFICERS' WIDOWS AND ORPHANS FUND FOR THE YEAR ENDING DECEMBER 31, 1915.

The Committee have the honour to present the following Report on the affairs and to submit the accounts of the Society for the year ended December 31, 1915.

Founded on January 1, 1816, at the close of the Napoleonic war, the Society completes the first hundred years of its existence in the midst of another great war. It seems desirable that any review of its progress during the century should be postponed until this war has reached its end.

At the Annual General Meeting held in May, 1915, Col. Douglas Wardrop, C.V.O., was appointed a Trustee of the Society in the place of Lieut.-Col. Alfred Clarke, who resigned office through ill-health. Col. W. H. Horrocks, K.H.S., was elected a member of the Committee.

During the past year the deaths of five members of the Society have been reported. Of these Col. Neville Manders was killed in action at the Dardanelles. That officer and Capt. O'Brien Butler, killed in Ypres in 1914, are, so far, the only members of the Society who have lost their lives on service—a small proportion considering the heavy losses of the Royal Army Medical Corps. One of the oldest members of the Society, Surg.-Gen. Sir Charles Cuffe, K.C.B., died in October last, who had for many years taken an active part in the management in the Society, and whose help and advice will be much missed. One member has resigned and two married members have joined. Five fresh Annuitants have been placed on the list, and four have died. Details will be found in the list of members.

Several changes have taken place in the investments of the Fund during the past year.

The amount of £100,855 7s. 5d. on the present balance sheet representing the deposit with the Commissioners for the Reduction of the National Debt, is made up thus:—

		£	s.	d.
Balance at December 31, 1914		104,533	8	11
Add Interest at £3 16s. 0¼. per cent. per annum		3,921	18	6
		£108,455	7	5
Deduct—				
Amount withdrawn for purchase of War Stock ..	£6,600			
,, ,, for payment of annuities ..	1,000			
		7,600	0	0
Balance as per Balance Sheet		£100,855	7	5

The question, referred to in the last Annual Report, of withdrawing and investing at a higher rate of interest the large sum on deposit with the National Debt Commissioners, has engaged the careful attention of the Committee with all expert advice available. The matter was submitted to the National Debt Commissioners last

ARMY MEDICAL OFFICERS' WIDOWS AND ORPHANS FUND.

ACCOUNTS FOR THE YEAR 1915.

(In the form prescribed for the Annual Return of a Registered Friendly Society.)

(A) BENEFIT FUND.

Dr.

Income.	£	s.	d.
Members' Subscriptions..	2,238	5	3
Interest on Investments of Benefit Fund (including amounts refunded and recoverable in respect of Income Tax)	6,133	1	5
Total Income	£8,371	6	8
Amount of Benefit Fund at the beginning of the year, as per last Balance Sheet	140,078	2	3
	£148,449	8	11

Cr.

Expenditure.	£	s.	d.
Widows' Annuities	4,096	14	9
Interest on £5,506 3s. 6d. (balance of Management Fund at the end of the year 1914) at 3 per cent, transferred to Management Fund	165	3	8
Amount of Depreciation of the Market value of Securities as at December 31, 1915, written off ..	9,464	12	3
Total Expenditure	£13,726	10	8
Amount of Benefit Fund at the end of the year, as per Balance Sheet (C)	134,722	18	3
	£148,449	8	11

(B) MANAGEMENT FUND.

Dr.

Income.	£	s.	d.
Interest for one year on £5,506 3s. 6d. at 3 per cent, transferred from Benefit Fund	165	3	8
Management Fund at the beginning of the year, as per last Balance Sheet	5,506	3	6
	£5,671	7	2

Cr.

Expenditure.	£	s.	d.
Secretary's Salary	150	0	0
,, Office Allowance	60	0	0
Actuary's Fees	10	10	0
Auditors' Fees	10	10	0
Printing, Postages, and Stationery	12	18	11
Expenses of Transfer of Securities	19	17	2
Total Expenditure	£263	16	1
Amount of Management Fund at the end of the year, as per Balance Sheet (C)	5,407	11	1
	£5,671	7	2

(C) BALANCE SHEET AT DECEMBER 31, 1915.

Dr. Liabilities.	£	s.	d.
Benefit Fund, as per Account (A)	134,722	18	3
Management Fund, as per Account (B)	5,407	11	1
Sundry Liabilities—			
Secretary's Salary and Office Allowance (from October 1 to December 31, 1915)	52	10	0
Actuary's Fee	10	10	0
Annuities outstanding	111	3	0
Subscription overpaid	17	19	3
	£140,322	11	7

To the Members of the Army Medical Officers' Widows and Orphans Fund.

We have examined the above Balance Sheet with the Books and Vouchers of the Society and certify that it is in accordance therewith. The Securities and Cash Balances have been verified by us.

DELOITTE, PLENDER, GRIFFITHS AND CO., *Auditors*, *Chartered Accountants.*

5, *London Wall Buildings,*
Finsbury Circus, E.C.
April 17, 1916.

Assets. Investments.	Nominal £	s.	d.	Rate per cent of Interest yielded £	s.	d.	Cr. £	s.	d.
(1) With the Commissioners for the Reduction of the National Debt—Old Account, at 2½d. per cent per diem				3	16	0½	100,855	7	5
(2) In the Public Funds—									
War Stock—Four and a Half per Cent	£10,000	0	0	4	12	8	9,712	10	0
Dominion of Canada Three and a Half per Cent Stock, 1930-1950 ..	5,500	0	0	4	17	3	3,958	5	8
Newfoundland Three and a Half per Cent Stock, 1910	2,000	0	0	4	16	1	1,456	17	6
(3) Upon the Security of Borough and County Rates, or other Corporate Funds—									
London County Council Three and a Half per Cent Stock ..	5,000	0	0	4	9	10	3,893	15	0
Metropolitan Water Board "B" Three per Cent Stock ..	5,000	0	0	4	12	1	3,259	7	6
(4) Other Securities—									
Great Western Railway Four per Cent Debenture Stock	5,000	0	0	4	15	2	4,200	0	0
London and North Western Railway Three per Cent Debenture Stock	5,000	0	0	4	13	4	3,215	12	6
Caledonian Railway Four per Cent Debenture Stock	1,500	0	0	4	13	4	1,286	5	0
Midland Railway Two and a Half per Cent Debenture Stock ..	7,900	0	0	4	15	8	4,130	4	4
East Indian Railway Three and a Half per Cent Debenture Stock ..	2,100	0	0	4	17	7	1,506	15	0

Note—With the exception of the War Stock, which is valued at Market price, the above Securities have been valued at minimum list price, less 12½ per cent. as sanctioned by Somerset House for Probate purposes.

	£	s.	d.
Interest accrued on Investments	967	1	5
Income Tax recoverable	78	14	11
Subscriptions outstanding	12	0	0
Cash at Bankers	1,789	15	4
	£140,322	11	7

summer, when it was represented that the whole amount withdrawn would be re-invested in War Loan or other British Government securities. They replied as follows :—

"The withdrawal of large sums at present on deposit with the Commissioners would, under existing circumstances, be a matter of great embarrassment to His Majesty's Government, and the Chancellor of the Exchequer relies on the patriotism of depositors not to effect such withdrawals merely for the purpose of taking advantage of the higher rates of yield now ruling in the outside investment market."

Under these circumstances the Committee felt that they could not press their request.

At a later date, however, no objection was raised by the Commissioners to the withdrawal of a sum of £660, enabling sufficient War Loan to be purchased to convert the Consols (£4,917 18s. 10d.) then held by the Society into 4½ per cent War Loan. A small supplementary purchase of £121 7s. 6d. of this stock brought the total holding up to £10,000.

Small purchases of the following Railway Stocks were made to bring the holdings up to round hundreds :—

	£	s.	d.
Caledonian Railway 4 per cent Debenture Stock	51	0	0
Midland Railway 2½ per cent Debenture Stock	72	14	5
East Indian Railway 3½ per cent Debenture Stock	40	0	0

During the present year (1916) £700 of current balances has been invested in Exchequer 5 per cent. Bonds, and it is intended to increase this investment out of surplus balances from time to time.

The book values of the Stock Exchange Securities in the Balance Sheet at the end of the year 1915 have been written down in the Revenue account, upon expert advice, by the sum of £9,464 12s. 3d.; but of this sum £4,305 1s. 10d. had accrued at December 31, 1914, as mentioned in last year's Report.

The accompanying Report of the Actuary on his quinquennial valuation of the liabilities of the Fund shows that its financial position continues to be eminently satisfactory.

W. G. Don, *Deputy Surgeon-General.*
Vice-President.
Chairman of the Meeting of this date.

Royal Army Medical College,
April 19, 1916.

AUXILIARY ROYAL ARMY MEDICAL CORPS WIDOWS' AND ORPHANS' FUND.

A meeting was held at the Royal Army Medical College on Thursday, June 1, 1916, to consider the desirability of establishing funds raised by voluntary contribution for the benefit of widows and orphans of officers and of other ranks, of the Special Reserve, Territorial Forces and temporary branches of the Royal Army Medical Corps, who serve during the War and who die without making sufficient provision for their families.

Surg.-Gen. Sir Alfred Keogh, Director General A.M.S., addressed the meeting and pointed what steps are taken in the regular Royal Army Medical Corps to meet such contingencies, and how very desirable it is, now during mobilization, that some effort should be at once taken by the Auxiliary Branches of the Royal Army Medical Corps among themselves, to meet cases of distress in the families of both officers and men which must and will occur after the War. He left it entirely to the meeting to decide, whether or no any such action should be taken; and if so, whether there should be a separate fund for each of the three branches—viz., the Special Reserve, the Territorial Force and the temporary officers of the Regular Service, or one fund and one committee embracing the three branches.

The meeting was well and representatively attended. After considerable discussion in which many of those present took part, Major Ewen Maclean proposed the following resolution which was seconded by Col. Culver James and carried unanimously: "That a fund in connexion with the officers of the Auxiliary Branches of the Royal Army Medical Corps be formed and that a committee be appointed representative of the three branches to formulate a scheme and to report to a further meeting." Col. Westmacott proposed: "That the aforesaid committee be also requested to consider and report as to the possibility of establishing a General Relief Fund for the rank and file of the same forces. This was seconded by Major A. C. Farquharson and carried unanimously.

The Director-General then asked the meeting to elect from among themselves a Provisional Committee to consider and report on the above resolutions.

The following officers were then elected to form a Provisional Committee, which they consented to do, with power to add to their number:—

Col. W. Culver James (T.F.).
Col. J. Atkins, C.M.G.
Lieut.-Col. Sir John Collie.
Lieut.-Col. H. H. Tooth, C.M.G. (T.F.).
Major Ewen Maclean (T.F.).
Major G. Newton Pitts (T.F.).
Capt. R. J. Stirling (S.R.I.).
and Lieut.-Col. F. W. H. Davie Harris as Secretary.

A vote of thanks to the Director-General was proposed and carried unanimously.

ROYAL ARMY MEDICAL CORPS OFFICERS' BENEVOLENT SOCIETY.

PROCEEDINGS OF THE ANNUAL GENERAL MEETING HELD IN THE LIBRARY OF THE ROYAL ARMY MEDICAL COLLEGE, ON MONDAY, JUNE 19, 1916.

Surg.-Gen. Sir Alfred Keogh, K.C.B., Director-General A.M.S., President, in the Chair.

The Minutes of the last Annual General Meeting were read and confirmed.

The Report of the Committee, the Accounts for the year 1915, and the Auditors' report were received and adopted.

The following were re-elected Vice Presidents for the present year:—

Col. J. Lane Notter.
Col. Sir James Clark, C.B., Bart.
Surg.-Gen. M. W. Russell, C.B.

A letter was read from Col. Murray Irwin, resigning his seat on the Committee.

The following Committee was elected for 1916.

Col. W. H. Horrocks, K.H.S.
Lieut.-Col. E. M. Wilson, C.B., C.M.G., D.S.O.
Lieut.-Col. E. M. Pilcher, D.S.O.
Lieut.-Col. A. B. Cottell.
Surg.-Gen. Sir David Bruce, C.B., F.R.S.
Col. H. W. Murray.
Col. A. Peterkin.

The meeting having duly considered the applications, sanction was given to the following grants to applicants which had been recommended by the Committee:—

Three orphans of the late Staff-Surg. D. O. D.	£30
Orphan of Surg.-Major C. Q.	30
Orphan of Insp.-Gen. D. A.	35
Orphan of Surg.-Gen. A. S.	20
Orphan of Lieut.-Col. H. C.	25
Orphan of Surg.-Gen. J. O.	40
Orphan of Surg.-Gen. W. F. I.	40
Orphan of Surg.-Gen. T. B.	40
Orphan of Surg.-Major B. C. S.	35
Orphan of Major P. G. I.	30
McGrigor's Pension	10
Three orphans of Capt. G. C.	40
Orphan of Surg.-Gen. R. C.	30
Orphan of Surg.-Gen. J. W. M.	20
Orphan of Staff-Surg. J. W. C.	25
Orphan of Surg.-Gen. W. T. H.	25
Orphan of Surg.-Gen. J. F.	30
Two orphans of Lieut.-Col. H. J. P.	10
Eight orphans of Lieut.-Col. J. W.	40
Orphan of Lieut.-Col. H. P. E.	10
Orphan of Capt. T. S.	20
Two orphans of Capt. R. D. O'C.	20
Orphan of Lieut.-Col R. J. H.	20
Three orphans of Lieut.-Col. T. McC.	40
Thirty-eight orphans recommended to receive	£665

A letter was read from Mrs. S. asking for a grant for her daughter, the orphan of Capt. H. H. S. It was resolved that she should be given a grant of £20.

It was resolved that the two donations of £50 received from the Medical Insurance Agency and £10 10s. received from the S. W. London Medical Society, earmarked by the Committee to be used for the orphans of officers who have held temporary commissions in the R.A.M.C., be transferred to the Benevolent Branch of the Auxiliary R.A.M.C. Funds.

On the proposal of Surg.-Gen. Babtie, secondedby Col. H. W. Murray, it was resolved "That in the opinion of this Meeting, the present division of the working expenses between the R.A.M.C. Fund and the R.A.M.C. Officers' Benevolent Society, is not equitable, that representation should be made to the R.A.M.C. Fund Committee on the subject, proposing that the R.A.M.C. Fund should pay two-thirds and the Benevolent Society one-third of such expenses.

F. W. H. Davie Harris, *Lieut.-Col.*,
124, *Victoria Street, S.W.* *Secretary.*

REPORT OF THE COMMITTEE FOR THE YEAR 1915.

(1) The number of subscribers for the year was 168, and the amount of subscriptions was £176 10s. 6d.

(2) The donations amounted to £79 13s.; of this amount £50 was received from the Medical Insurance Agency, and has been earmarked for the benefit of orphans of officers who held temporary commissions in the Royal Army Medical Corps.

(3) The total receipts amounted to £973 13s. 2d.

(4) The total expenditure amounted to £725 18s. 3d.

(5) Twenty-five applicants representing forty-one orphans were granted £630, varying in amounts up to £4.

F. W. H. Davie Harris, *Lieut.-Col.*,
Secretary.

ROYAL ARMY MEDICAL CORPS OFFICERS' BENEVOLENT SOCIETY.

STATEMENT OF ACCOUNTS FOR THE YEAR 1915.

RECEIPTS.		£	s.	d.
To Balance in Bank, January 1, 1915		383	4	6
,, Subscriptions		176	10	6
,, Rebate of Income Tax		85	2	8
,, Donations—				
Medical Insurance Agency	£50 0 0			
S.W. London Medical Society	10 10 0			
Mrs. Hayes	10 0 0			
E. J. Hopwood, Esq.	3 3 0			
Lieut.-Col. H. V. Prynne	6 0 0			
		79	13	0
,, Refund Postage R.A.M.C. Comforts		2	0	0
,, Dividends—				
North Eastern Railway 3 % Debenture Stock (*less* tax £19 11s. 8d.)		180	7	10
London & North Western Railway Debenture Stock (*less* tax £19 15s. 10d.)		180	4	4
Midland Railway Debenture Stock (*less* tax £15 13s. 4d.)		144	6	8
Caledonian Railway Debenture Stock (*less* tax £15 3s. 8d.)		96	0	4
Consols		29	7	10
		£1,356	17	8

EXPENDITURE.	£	s.	d.
By Grants	630	0	0
,, Auditor's Fee	1	1	0
,, Secretarial and Office Expenses	90	0	0
,, Stationery	1	19	0
,, Printing	0	10	6
,, Postage	2	11	0
,, Share of Typewriting Machine	9	15	9
,, Verification of Consols	0	1	0
,, Balance in Bank, December 31, 1915	620	19	5
	£1,356	17	8

INVESTMENTS.	£	s.	d.
London & North Western Railway 3 % Debenture Stock	6,667	0	0
North Eastern Railway 3 % Debenture Stock	6,666	0	0
Midland Railway 2½ % Debenture Stock	6,400	0	0
Caledonian Railway 4 % Debenture Stock	2,780	0	0
Consols	1,327	7	9
	£23,840	7	9

We have compared the above statement with the books and papers relating thereto, and certify that it is correct. We have verified the Bank Balance and the Investment in Consols, and have inspected the Certificates of the Investments in Railway Stocks as set out.

Portland House,
Basinghall Street, E.C.
January 6, 1916.

(*Signed*) EVANS, PIERSON & CO.,
Chartered Accountants.

LIST OF SUBSCRIBERS FOR THE YEAR 1915.

	£	s.	d.
Archer, Lieut.-Col. S. A.	£0	10	6
Alexander, Lieut.-Col. J. D.	1	1	0
Birrell, Lieut.-Col. E. T. F., C.M.G.	1	1	0
Babtie, Surg.-Gen. W., V.C., C.M.G., C.B.	1	1	0
Brodie, Lieut.-Col. J. F.	1	1	0
Beach, Col. T. B.	1	1	0
Bourke, Surg.-Gen. G. D., C.B.	1	1	0
Balck, Major C. A. J. A.	1	1	0
Begbie, Lieut.-Col. F. W.	1	1	0
Browne, Major W. W.	1	1	0
Boyd, Capt. J. E. M.	1	1	0
Bent, Mrs. G.	1	1	0
Blenkinsop, Col. A. P.	1	1	0
Bedford, Surg.-Gen. W. G. A., C.M.G.	1	1	0
Bewley, Col. A. W.	1	1	0
Clarke, Lieut.-Col. A. F. S.	1	1	0
Campbell, Lieut.-Col. J. H., D.S.O.	1	1	0
Churchill, Surg.-Gen. A. F.	1	0	0
Cottell, Lieut.-Col. A. B.	1	0	0
Corker, Surg.-Gen. T. M., C.B.	1	0	0
Chambers, Major A. J.	1	0	0
Cummins, Lieut.-Col. S. L., C.M.G.	1	1	0
Chopping, Lieut.-Col. A.	1	1	0
Churchill, Major G. B. F.	1	1	0
Cochrane, Lieut.-Col. E. W. W.	1	1	0
Cree, Col. G., C.M.G.	1	1	0
Cuffe, Surg.-Gen. Sir Charles, K.C.B.	1	1	0
Clapham, Capt. J. T.	1	1	0
Connor, Lieut.-Col. J. C.	1	1	0
Copeland, Col. R. J.	1	1	0
Chapman, Capt. F. H. M.	1	1	0
Clark, Col. Sir James, C.B., Bart.	1	1	0
Caruthers, Capt. V. T.	1	1	0
Casement, Capt. F.	1	1	0
Cowen, Capt. E. G. H.	1	1	0
Cumming, Lieut.-Col. C. C.	1	1	0
Croly, Col. A. E. J.	1	0	0
Davies, Lieut.-Col. A. M.	1	1	0
Donovan, Surg.-Gen. W., C.B.	1	1	0
Dive, Capt. G. F.	1	1	0
Dawson, Capt. G. F.	1	1	0
Evatt, Surg.-Gen. J. G. H., C.B.	1	0	0
Evans, Lieut.-Col. P., C.M.G.	1	1	0
Ellis, Surg.-Gen. P. M.	1	1	0
Fitzgerald, Major A. O.	1	1	0
Firth, Col. R. H.	1	1	0
Foulds, Major M. F.	1	1	0
Fletcher, Lieut.-Col. H. J.	1	1	0
Faichnie, Lieut.-Col. N.	1	0	0
Forrest, Lieut.-Col. J. V.	1	1	0
Fell, Lieut.-Col. M. H. G.	1	1	0
Ferguson, Col. N., C.M.G.	1	1	0
Ffrench, Major E. G.	1	1	0
Girand, Surg.-Major-Gen. C. H.	1	1	0
Girvin, Col. J.	1	1	0
Galwey, Capt. W. R.	1	1	0
Green, Lieut.-Col. J. S.	1	1	0

	£	s.	d.
Gerard, Col. J. J.	£1	0	0
Goggin, Col. G. T.	1	0	0
Geddes, Col. R. J., C.B., D.S.O.	1	1	0
Gatt, Major J. E. H.	1	0	0
Gibson, Capt. H. G.	1	1	0
Gubbins, Surg.-Gen. W. L., K.C.B., M.V.O.	1	1	0
Hackett, Col. R. J. D.	1	0	0
Hamerton, Major A. E. D., D.S.O.	1	1	0
Hardy, Lieut.-Col. W. E.	1	1	0
Herricks, Lieut.-Col. H.	1	1	0
Hall, Lieut.-Col. R. H.	1	1	0
Hassard, Lieut.-Col. E. M.	1	1	0
Hughes, Major G. W. G., D.S.O.	1	1	0
Holyoake, Lieut.-Col. R.	1	1	0
Horrocks, Col. W. H.	1	1	0
Harris, Lieut.-Col. F. W. H. Davie	1	1	0
Hodgson, Lieut.-Col. J. E.	1	1	0
Harwood, Col. J. G.	1	1	0
Hayes, Mrs. G. S. C.	10	0	0
Harding, Major D. L.	1	1	0
Hatheway, Surg.-Gen. H. G., C.B.	1	1	0
Heale, Capt. A. S.	1	1	0
Hayes, Capt. L. C.	1	1	0
Jennings, Col. R.	1	0	0
James, Col. H. E. R., C.B.	1	1	0
Irwin, Col. J. M.	1	1	0
Jones, Col. F. W. C., C.B.	1	1	0
Jones, Col. J. M.	1	1	0
Jameson, Lieut.-Col. J. C.	1	0	0
Kirkpatrick, Col. R., C.M.G.	1	1	0
Jameson, Major A. D.	1	1	0
Knox, Col. M.	1	0	0
Keogh, Surg.-Gen. Sir A., K.C.B., F.R.S.	1	1	0
Kenny, Surg.-Gen. W.	1	1	0
Kelly, Major W. D. C.	1	1	0
Longmore, Lady	1	1	0
Lunne, Capt. W. E. C.	1	1	0
Lane, Lieut.-Col. W. L.	1	0	0
Leake, Col. G. D. N.	1	1	0
Lelean, Major P. S.	1	1	0
Long, Major H. W.	1	1	0
Langrishe, Capt. J. de P.	1	0	0
Loughman, Capt. W. F. N.	1	1	0
Lynden Bell, Col., C.B.	1	1	0
Levack, Capt. J. S.	1	1	0
Martin, Col. W. F.	1	1	0
Macloughlin, Major A. M.	1	1	0
Macpherson, Surg.-Gen. W. G., M.B., C.B., C.M.G.	1	1	0
Mould, Lieut.-Col. W. T.	1	0	0
Murray, Col. H. W.	1	1	0
May, Col. W. A., C.B.	1	1	0
McSheehy, Major E. L.	1	1	0
Mangin, Lieut.-Col. F. M.	1	0	0
McDougal, Lieut.-Col. A. J.	1	1	0
MacKenzie, Lieut.-Col. T. C.	1	1	0
MacLoughlin, Lieut.-Col. G. S., C.M.G., D.S.O.	1	1	0
Martin, Lieut.-Col. C. B.	1	1	0
Morris, Lieut.-Col. A. H.	1	1	0
McEwen, Capt. O. R.	1	1	0

	£	s.	d.
Mosse, Col. C. G...	£1	1	0
Mackenzie, Capt. D. F. ..	1	0	0
Maher, Col. J.	2	0	0
Myles, Major C. D.	1	0	0
Myles, Major E. H.	1	1	0
MacNeece, Surg.-Gen. J. G., C.B.	1	1	0
Notter, Col. J. Lane	1	0	0
Nash, Col. L. T., C.M.G.	1	1	0
Pocock, Col. H. J.	1	0	0
Profeit, Lieut.-Col. C. W.	1	1	0
Porter, Surg.-Gen. R.	1	1	0
Poynder, Lt.-Col. G. F.	1	1	0
Paterson, Major Ian	1	1	0
Phelan, Capt. E. C.	1	1	0
Pilcher, Lieut.-Col. G. M., D.S.O.	1	1	0
Prynne, Lieut.-Col. H. V.	6	0	0
Ritchie, Major M. B. H.	1	1	0
Risk, Col. E. J. E.	1	1	0
Rowan, Col. H. D.	1	1	0
Russell, Surg.-Gen. M. W., C.B.	1	1	0
Rugg, Major G. F.	1	1	0
Reilly, Col. C. C.	1	0	0
Robinson, Major E. F. Rowan..	1	1	0
Roch, Lieut.-Col. H. S...	1	1	0
Rutherford, Lieut.-Col. J. C., D.S.O.	1	1	0
Sinclair, Surg.-Gen., C. M., C.B.	1	1	0
Smithson, Major A. E. ..	1	1	0
Symons, Lieut.-Col. J. T. M.	2	0	0
Stallard, Lieut.-Col. H. C. F.	1	0	0
Sewell, Lieut.-Col. E. P.	£1	1	0
Sloggett, Surg.-Gen. Sir Arthur, K.C.B., C.M.G.	1	0	0
Staddon, Lieut.-Col. H. E.	1	1	0
Stephens, Major F. A., D.S.O.	1	1	0
Smith, Major S. Boylan	1	1	0
Stack, Capt. G. H.	1	1	0
Townsend, Surg.-Gen. Sir E., K.C.B.	1	1	0
Tatham, Lieut.-Col. C. J. W.	1	1	0
Trevor, Col. H. O.	1	1	0
Thompson, Capt. W. I...	1	1	0
Taylor, Capt. G. P.	1	1	0
Vivian, Capt. R. T.	1	1	0
Vaughan, Capt. E. W. ..	1	1	0
Windle, Col. E. J.	1	0	0
Wardrop, Col. D., C.V.O.	1	1	0
Williamson, Col. J. G. ..	1	1	0
Woodhouse, Surg.-Gen. T. P., C.B.	1	1	0
Whitehead, Surg.-Gen. H. R., C.B.	1	1	0
Waring, Lieut.-Col. A. H.	1	1	0
Watts, Lieut.-Col. B.	1	1	0
Wilson, Lieut.-Col. E. M., C.B., C.M.G., D.S.O.	1	1	0
Winder, Major M. G.	1	1	0
Whipple, Col. J. C.	1	1	0
Wood, Capt. J. L.	1	1	0
Young, Lieut.-Col. A. H. O.	1	1	0

ROYAL ARMY MEDICAL CORPS FUND.

The fourteenth Annual General Meeting of the Royal Army Medical Corps Fund, held at the Royal Army Medical College on Monday, June 19, 1916, the Director-General Surg.-Gen. Sir Alfred Keogh, K.C.B., in the Chair.

REPORT OF THE COMMITTEE.

The Royal Army Medical Corps Fund Committee undertakes, with the assistance of Sub-Committees, the management and administration of the Royal Army Medical Corps Fund. The Corps Fund embraces the Dinner, the Band and the Memorials. The General Relief and the Compassionate Funds, are also administered and controlled by this Committee.

Committee.—The Committee consists of thirteen members, nine taken from the active list of officers, who are all ex-officio and hold office for the tenure of their appointments, and four representatives of retired officers, who are elected by the Committee, from time to time as vacancies occur, and hold office for four years.

The following changes have taken place in the Committee during the past twelve months: Major W. A. Ward has succeeded Major Benson as representative for the Band, Lieut.-Col. Thom has replaced Lieut.-Col. Blackwell and Lieut.-Col. E. M. Wilson has taken the vacancy among retired officers occasioned by the lamented death of Lieut.-Col. E. O. Wight.

Finance.—The accounts are made up to December 31 annually, and after being audited, are considered and passed by the Committee of the January meeting and then published in the February number of the Corps News.

On June 1 of this year the finances of the Fund stood as follows:—

		£	s.	d.
R.A.M.C. Fund:	Current account	662	19	1
	Investments	4,265	0	0
		£4,927	19	1
General Relief:	Current account	307	0	7
	Investments	4,066	1	3
		£4,373	1	10
School Fund:	Current account	146	8	3
	Deposit account	100	0	0
		£246	8	3

making a total of £9,507 as compared with a total of this time last year £7,158. The Committee invested for the Royal Army Medical Corps Fund during the year £795 14s. 2d. in the purchase of £800 War Loan, 1915.

Subscribers.—The number of subscribers for 1915 was 1,096 as compared with 1,114 for 1914; the decrease is accounted for by the War having made inroads by death in the old subscribers as well as the fact that no officers having been given commissions in the Corps during the War no fresh subscribers have joined the Fund. The Committee passed a resolution that a circular letter should be sent to all re-employed retired officers who had ceased to subscribe, inviting them to again become subscribers, this resulted in eighteen favourable responses. There are still a large number of officers on the active list who do not subscribe to the Fund.

Band.—During the year 1915 £138 was voted by the Committee out of the Fund towards the upkeep of the Band at Aldershot. The Committee have authorized the retention of the bandmaster's services until the end of the year 1916, when the question will be again considered, and as there is no doubt that the Band is doing good work at Aldershot, there is no reason to suppose that his services will be dispensed with during the War.

Dinner.—As no dinner was held last year, there are no remarks to make on the subject.

Memorials.—Besides the usual premium for Fire Insurance of the Queen Alexandra's Military Hospital Chapel, the subscription to the Royal School for Officers' Daughters, and the annual donation to the General Relief Fund, the only expenditure last year under this head was a sum of £150 voted by the Annual General Meeting to Mrs. Johnston, towards the expenses of the publication of "A History of the Corps" by Col. W. Johnston, C.B. No alteration in the constitution of the Memorial Sub-Committee was made during the year. Surg.-Genls. Russell and Sir David Bruce still are members.

General Relief Fund.—During the year 1915 £413 0s. 4d. was received in grants from Companies, and £80 from the Royal Army Medical Corps Fund, and a donation of £30 from Lady Saunders and Miss Eastman, being the proceeds of a concert held by them in Zululand, and sent to us through Col. Blenkinsop. Besides the annual subscriptions paid by the General Relief Fund, namely, the Union Jack Club, Corps of Commissionaires, Soldiers' and Sailors' Help Society, Association for the Employment of ex Soldiers. Army and Navy Male Nurses Corporation, &c., £21 was given in grants to Companies, £100 was given to the Royal Army Medical Corps Comfort Fund, and £600 was invested in the War Loan 1915.

Compassionate School Fund.—This Fund paid last year £74 towards the maintenance of children of the Corps at schools at which we have at present nine children. There is now about £246 remaining in the Fund. You will be asked to-day to discuss and decide a question with regard to the future of this Fund, which has been placed on the Agenda and referred to this Meeting by your Committee. The School Fund was started after the South African War with a sum of about £1,300, which was earmarked by Col. Somerville Large, who transferred the money from his regimental institutes in South Africa to provide free education and maintenance for orphans of our N.C.O.s and men who served in the South African War. It has been kept

independently of the General Relief Fund and administered by the Royal Army Medical Corps Committee but is now approaching exhaustion.

The Secretary, Lieut.-Col. Davie Harris, read the report of the Committee, which was carried.

(2) The next item on the Agenda was then brought forward, viz.: To consider the question of giving a grant to the General Relief Fund. The Secretary explained that for many years past we had been contributing to this Fund, by making a donation from the Royal Army Medical Corps Fund to the General Relief Fund; this was the only subscription the officers gave to the men. Last year we gave the sum of £80 which was more than had been subscribed in previous years.

Col. E. M. Wilson said that it originated with a small grant of £10; he thought it a very good thing that there should be a grant from the Royal Army Medical Corps Fund to the General Relief Fund. There was one great point about it, and that was that it avoided sending the hat round in individual cases. During the war we do not require so very much as the majority of cases were dealt with by the Prince of Wales' Fund. I should like to move that a grant be given the same as last year towards the General Relief Fund. It was therefore proposed by Col. Wilson that the sum of £80 be given towards the General Relief Fund, which was seconded by Col. Murray and carried.

(3) The next point on the Agenda was to consider a question referred by the Committee as to whether the General Relief Fund should be burdened with, and carry on the work hitherto done by the Compassionate School Fund when the finances of the latter are exhausted, and if so, whether the two Funds shall be amalgamated at the close of the present year.

The Chairman: How much have we in hand now?

Lieut.-Col. Davie Harris: At the end of this year we shall have about £180 or £200. We still have some children at school whom we have to see out. Our expenses run between £90 and £100 a year.

Col. Howell: I consider we should continue the Fund as it is until the end of the War, and then as we should have a meeting consisting possibly of 300 or 400 members and get the general opinion of attaching the School Fund to the General Relief Fund. I am afraid that when the Fund is exhausted there will be no means of reviving it unless you attach the School Fund to the General Relief.

The Chairman: I was going to propose that. You would, of course, like the children to be kept on who are now at school. I was going to ask whether the sum in hand was sufficient to allow the children to be kept there for the whole of their period?

Lieut.-Col. Davie Harris: The children leave at 16.

The Chairman: Are you in a position to take any children on this year?

Lieut.-Col. Davie Harris: No, Sir.

Col. Wilson said he thought it would be better to merge the School Fund into the General Relief Fund.

Surg.-Gen. Sir W. Babtie: That might possibly become a big question.

The Chairman: The question arises whether any other children can be taken during this War, and whether the Committee should have power to pay for their schooling.

It was therefore proposed by Col. E. M. Wilson, and seconded by Sir W. Babtie and carried, "that a sum may be paid out of the General Relief Fund, for the maintenance of three children during the next twelve months."

(4) The next item on the Agenda was as to the appointment of auditors for the current year. The present auditors were Col. E. M. Wilson and Surg.-Gen. Jencken, whose names were again put forward, and carried.

Lieut.-Col. F. S. Irvine said he would like to ask a question as to how the Band stands as to the Bandmaster, as he understood his salary had been passed by the Committee till the end of the year only. If they got rid of the Bandmaster it would be very unwise. We have a most excellent band and I think for anything to interfere with it would be a great mistake. I believe the music has been cut down considerably lately, but nevertheless the band is much appreciated, and I have just raised this question so as to know its position; as I was rather alarmed to hear the Bandmaster's salary had only been voted for one year.

The Chairman: I see £138 was voted last year. Was that more than usual?

Col. Harris: Previous years they had more than £300, but when the War broke out, the question arose as to whether we should continue the Band? It was decided that the Bandmaster and Serjt. Bugler should be retained during 1915; then the question was brought up again and it was decided to continue during 1916.

The Chairman: Well now, Col. Irvine, I am not quite clear what you would like us to do.

Lieut.-Col. Irvine: I think that the Bandmaster's services should not be continued from year to year but should be continued as a permanency. I should like the Band to continue as in peace conditions. It plays at the officers' club, funerals, &c., and I think there should be no uncertainty about it.

The Chairman: I agree with every word you say and I think the Committee feel as you do. I do not think the Committee has anything to do with the Band except as to giving contributions.

Surg.-Gen. Sir W. Babtie: Which it does yearly.

The Chairman: Whether the Bandmaster remains or not rests with you.

Surg.-Gen. Sir W. Babtie: Have you enough funds to carry on till the next annual General Meeting, or enough to go on with till the end of this year? These facts ought to be brought before the Committee.

Col. E. M. Wilson: I think it would be a good thing to vote the sum of £100.

The Chairman: Certainly.

It was therefore proposed by Col. E. M. Wilson and seconded by Surg.-Gen. Sir William Babtie that the sum of £100 be granted towards the Band Fund. Carried.

AUXILIARY ROYAL ARMY MEDICAL CORPS' FUNDS.

A GENERAL meeting was held at the Royal Army Medical College on Monday, June 26, 1916. Surg.-Gen. Sir Alfred Keogh, K.C.B., F.R.S., D.-G., A.M.S., was in the Chair.

The Chairman took the sense of the meeting as to whether the Press should be admitted. It was decided that it should.

The minutes of the last meeting were read and confirmed.

The Chairman then addressed the meeting, calling attention to the adverse criticism which had appeared in the *British Medical Journal*. He said it was a question to be decided whether the scope of the scheme should be extended to other medical men than those holding commissions, and he said he had received a communication from Col. Westmacot, of Birmingham, offering a donation of £20 to assist in starting the funds.

He called on the Secretary to read the scheme formulated by the Provisional Committee, which had been printed in the *Lancet*.

Col. Culver James, H.A.C., proposed: "That the scheme of the Provisional Committee be received and adopted, and be carried into effect forthwith." He said that the original idea for which the meeting was called should be upheld, and that no notice should be taken of the hostile criticism which appeared in the *British Medical Journal*. He begged to differ from the Chairman that the article in question would in any way prejudicially affect the success of the proposal, provided that the scope was limited to benevolence and relief. He pointed out how very successfully similar funds had been run in the Regular Royal Army Medical Corps, and advised the meeting to approve of the Committee's report.

Major Ewen Maclean seconded the proposal of Col. Culver James, and said that as an old member of the British Medical Association he considered the article in that journal was not of the best taste. He could not agree with the Chairman that the publication should or would in any way affect the success of the original proposition, provided they were kept purely military, and confined solely to the Auxiliary Royal Army Medical Corps Forces. He strongly urged the meeting to support the scheme, and suggested that widows should be allowed to participate in the benefits of the Officers' Benevolent Branch as well as orphans.

Major F. Charlesworth and Lieut.-Col. Collum advised postponing the adoption of the scheme until it had been circulated and considered by the officers of the Auxiliary Royal Army Medical Corps.

Col. J. Atkins, C.M.G., and Lieut.-Col. Bruce Porter advocated that the scheme should be extended so that a Loan Fund could be established with a view of re-establishing medical officers in their practices at the cessation of hostilities.

Major Ewen Maclean pointed out that such a Loan Fund would be a large undertaking, and beyond the scope of the Compassionate Funds; also that the money given for benevolence and relief could not be applied for other purposes, such as loans, without the consent of the donors and subscribers. He considered that if the meeting attempted too much it would fail, but if it confined itself to the scheme it would succeed, and that a Loan Fund was a question for the civil medical practitioner, and not for a military body to decide. Further, it should have a separate and independent committee of its own.

Major A. O. Farquharson strongly condemned the article in the *British Medical Journal*, and asked the meeting to take no notice of it. He strongly urged the meeting to go on with the scheme, not to waste valuable time in discussing side issues, and not to allow itself to be led away by premature adverse criticism. He offered a donation to start the Fund if it was proceeded with forthwith.

The Chairman again addressed the meeting, saying he had allowed considerable latitude in the discussion and was about to put the resolution to the meeting, when Major Todd moved the following amendment: "That the report be received and circulated so that meetings may be called in the various areas for its consideration, and a further meeting be held in a month." This amendment was seconded, put to the meeting and carried.

It then became the substantive motion. Several officers then left the room.

Colonel Atkins moved: "That it was in the opinion of this meeting that the scope of the Auxiliary Royal Army Medical Corps Benevolent Fund be such as to permit of the establishment of a Loan or such other Fund which may be deemed desirable for relieving cases of temporary financial embarrassment due to the exceptional conditions of service of the three Auxiliary Branches of the Royal Army Medical Corps."

A vote of thanks to the Chairman was proposed and carried.

A vote of thanks to Lieut.-Col. Harris for the services he had rendered to the Provisional Committee was also proposed and carried.

At a Meeting held in connection with the above of the Royal Army Medical College on Monday, June 26, 1916, the following resolution was carried unanimously:—

"That the report be received and be circulated, so that meetings may be called in the various areas for its consideration, and a further meeting be held in a month."

The report is as follows:—

Report of a Scheme formulated by the Provisional Committee.

That two independent Funds be formed, one a Benevolent Fund for officers orphans, the other a Relief Fund, for the widows and orphans of the rank and file of the Auxiliary Royal Army Medical Corps Forces.

The designation of the Funds shall be: Auxiliary Royal Army Medical Corps Funds: (*a*) Officers' Benevolent Branch; (*b*) Relief Branch.

These funds shall embrace the three Auxiliary Branches of the Corps—namely, the Special Reserve, the Territorials, and those holding temporary appointments in the Royal Army Medical Corps.

One Committee shall administer the two branches; such committee shall be representative of the three Auxiliary Branches of the Corps, and shall consist of a President, three Vice-Presidents, a Committee of twelve members and a Secretary.

The meetings of the Committee shall be held in London, and the working expenses shall be divided *pro rata* between the Benevolent and Relief Branches.

Officers' Benevolent Branch.

This Fund shall adopt the rules of the Royal Army Medical Corps Officers' Benevolent Society, as far as they are applicable, and a Sub-Committee shall be appointed to draw up a set of rules on those lines. The object of the Officers' Benevolent Branch shall be to afford pecuniary assistance to the orphans of officers who have held commissions in the Auxiliary Branches of the Royal Army Medical Corps during this War and who are in necessitous circumstances, the more especially to assist in the education and the starting in life of the orphans.

The orphans of those officers who have been killed in action or have died of wounds received in action or of disease caused by active service shall have the first claim on the Fund and shall have precedence over all others.

The orphans of officers who die after the War or after relinquishing their commissions, and whose deaths are directly attributable to War service, shall have the second call on the Fund.

The orphans of officers who have held commissions during the War period, but whose deaths are not directly attributable to war service, shall follow the foregoing in precedence.

Orphans of officers who are non-subscribers to the Fund shall have no claim on its benefits.

Grants may be continued up to the age of 21 for boys and 18 for girls; should, however, a girl orphan marry, the Committee may, at their discretion, make a grant towards the expenses of her marriage outfit, although she is over the prescribed age.

Should a female unmarried orphan be over the age of 50, or should she be medically unfit to contribute towards her own maintenance if below that age, the Committee may make her a grant, as a special case—provided, of course, that she is in needful circumstances.

All grants shall be made in the form of donations, not as pensions, and the fact of a grant being made one year shall not in any way give an applicant any claim for a future year; all claims shall be decided annually on their individual merits.

As the Officers' Benevolent Branch will have to be maintained entirely by subscriptions and donations, it is hoped that every officer of the Auxiliary Royal Army Medical Corps will at once become a subscriber, and that those able to do so will give a donation to assist in starting the Fund.

The minimum subscription shall be one guinea per annum. This shall entitle the subscriber to a vote at the annual meetings. The Committee hope that this minimum will be exceeded by many.

In order to facilitate the collection of subscriptions, it is requested that officers will kindly sign the bankers' order form which will be sent to them, as this will ensure the prompt payment on January 1, yearly.

Relief Fund.

The object is to assist the widows and orphans of the rank and file of the Auxiliary Branches of the Royal Army Medical Corps—viz., the Special Reserve, the Territorials, and the men who have enlisted for the period of the War and do not transfer to the Regular Forces on the termination of their engagements.

Relief will only be given after full inquiry and verification of the facts of each case, then only to relieve urgent cases of distress arising from ill-health, unemployment or death.

Relief will only be given in small money grants; no one will be allowed to become a pensioner on the Fund.

The Relief Branch will be worked, as far as possible, on the lines of the General Relief Fund of the Royal Army Medical Corps.

As the maintenance of this Fund will have to depend, chiefly, if not entirely, on donations and grants, and as, on demobilization, all grants from regimental institutes will naturally cease, the Committee consider that in order to secure a fixed income for this Branch, an endeavour should at once be made to raise a sum of at least £20,000, with a view of the Fund receiving a revenue from investments for future use, for without some such source of income the Committee fail to see how the Fund could last; it would meet an early death from exhaustion.

The Committee will be very grateful if the Director-General, A.M.S., will kindly assist them in making these Funds a success by causing the existence of them to be made known to all Auxiliary officers and by facilitating correspondence with them, also by giving official authority to officers commanding units, both at home and abroad, to make grants from their regimental institutes to the Relief Branch.

A further resolution was also unanimously carried, to the following effect:—

"That it is the opinion of this meeting that the scope of the Auxiliary Royal Army Medical Corps Benevolent Fund be such as to permit of the establishment of a loan or any other Fund which may seem desirable for relieving cases of temporary financial embarrassment due to the exceptional conditions of service of the three Auxiliary Branches of the Royal Army Medical Corps.

It is requested that this report may be forwarded to all officers commanding units and that these may be instructed to forward to the Director-General, Army Medical Service, War Office, Whitehall, S.W., not later than July 15, 1916, a report showing whether the scheme has the support of their officers.

ROYAL SCHOOL FOR DAUGHTERS OF OFFICERS, BATH.

Mrs. T. McCullock wishes to thank all the Corps and Royal Army Medical Corps officers, and their friends also, who so generously gave their votes at the last two elections, which have secured the second place for her daughter Margaret, with 4,784 votes.

BIRTHS.

KELLY.—May 30, 1916, at 89, Lower Baggot Street, Dublin, to Lieut.-Col. W. D. C. Kelly, R.A.M.C., and Mrs. Kelly (née Wolseley), a daughter.

POWELL.—On June 12, at Harrogate, the wife of Major Jack Powell, R.A.M.C., a son.

DEATHS.

LOUGHEED.—Surg.-Major James Winterscale Lougheed (retired), died at Sligo, on June 9, 1916.

FLETCHER.—Surg.-Major William Fletcher, Army Medical Service (retired), died at 10, Bishop's Mansions, Bishop's Park Road, S.W., June 15, 1916.

O'BRIEN.—Lieut.-Col. Henry Joseph O'Brien, R.A.M.C. (Retired), died at Whitepoint House, Queenstown, Cork, on April 16, 1916.

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

Captain E. L. Sandiland, M.B.Lond., D.P.H., R.A.M.C.(T.F.), 1/1st South Wales Mounted Brigade Field Ambulance, Cupar, Fife, is willing to exchange duties with an officer serving abroad, preferably in a London Field Ambulance, or in the Sanitary Service.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, and Proceedings of the United Services Medical Society.

Any demand for excerpts, additional to the above, or for reprints, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates:—

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12	4	0 2 9	0 1 2				
	8	0 5 0	0 2 3	4 3	1 1	3 10	0 9
	16	0 8 3	0 3 11				
25	4	0 3 4	0 1 5				
	8	0 6 0	0 2 9	4 10	1 6	4 4	0 11
	16	0 10 6	0 5 0				
50	4	0 4 6	0 1 10				
	8	0 7 6	0 3 6	6 0	2 1	4 10	1 2
	16	0 13 3	0 5 10				
100	4	0 6 0	0 3 1				
	8	0 10 0	0 4 10	7 10	3 11	6 7	2 5
	16	0 18 6	0 7 6				
200	4	0 9 6	0 4 5				
	8	0 15 0	0 6 7	10 10	7 6	9 0	4 10
	16	1 6 0	0 9 8				

* These are not arranged as Reprints, but appear precisely as in the Journal with any other matter that may happen to appear on the first and last pages of the particular excerpt ordered.

Cases for Binding Volumes.—Strong and useful cases for binding can be obtained from the publishers at the undermentioned rates:—

Covers, 1s. 8d. net; binding, 1s. 6d.

These charges are exclusive of cost of postage.

In forwarding parts for binding the name and address of sender should be enclosed in parcel.

The above figures are subject to 15 per cent. increase.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

All such Communications or Articles accepted and published in the "Journal of the Royal Army Medical Corps" will (unless the Author notifies at the time of submission that he reserves the copyright of the Article to himself) become the property of the Library and Journal Committee, who will exercise full copyright powers concerning such Articles.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W.

Communications have been received from Colonels A. Fullerton, R. H. Firth; Lieutenant-Colonels D. Harvey, J. R. Gourdi, M. H. Gordon, C. M. Wenyon, H. W. Webber; Surgeon Lieutenant-Colonel P. B. Bentlif; Majors E. C. Whitehead, J. K. Love; Captains T. C. Clare, D. Hingston, R. F. Bolt, J. B. Tombleson, F. W. O'Connor, H. A. Cookson, A. F. S. Sladden, H. J. Norman, J. Fraser, H. J. Bates, P. N. Vellacott, R. B. Blair, K. P. Mackenzie, D. C. Taylor, E. T. C. Milligan, M. Donaldson, E. Glynn; Lieutenants A. G. Faulds, G. E. Richards, H. E. Rawlence; R. J. Reynolds, Esq., M.B., I. Walker Hall, Esq., M.D., T. E. Harwood, Esq.; Professor L. E. Hill, F.R.S., R. T. Leiper, D.Sc., &c.; Serjeant A. R. Crane.

The following publications have been received:—

British: The St. Thomas's Hospital Gazette, Guy's Hospital Gazette, Medical Press and Circular, The Hospital, The Lancet, The Medical Journal of Australia, Proceedings of the Royal Society of Medicine, The Royal Engineers' Journal, The Practitioner, Journal of the Royal United Service Institution, The Medical Journal of South Africa, Red Cross and Ambulance News, The Medical Review, The Indian Medical Gazette, Annals of Tropical Medicine and Parasitology, Public Health, Bulletin of Entomological Research, St. Bartholomew's Hospital Journal, Tropical Diseases Bulletin, The Journal of State Medicine, Journal of Tropical Medicine and Hygiene.

Foreign: United States Public Health Service, Office International d'Hygiene Publique, Bulletin de l'Institut Pasteur, Bulletin of the Johns Hopkins Hospital, Bulletin de la Société de Pathologie Exotique, Archives de Médecine et de Pharmacie Militaires, Revista de Sanidád Militar, United States Journal of Agriculture Research, Norsk Tidsskrift fur Militaermedicin, Giornale di Medicina Militare, l'Ospedale Maggiore, The Military Surgeon, The Journal of Infectious Diseases, Le Caducée,

MANAGER'S NOTICES.

The Journal of the Royal Army Medical Corps is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Chequse or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

The Hon. Manager,
"Journal of the Royal Army Medical Corps,"
War Office, Whitehall, S.W.

JOURNAL

OF THE

ROYAL ARMY MEDICAL CORPS.

Corps News.

August, 1916.

D.C.M.G.

O.B.A. 1686, dated July 4, 1916 A.

The Commander-in-Chief directs me to convey to you and through you to the Directors and all concerned under them his high appreciation of their hard work and the efficiency of arrangements for dealing with the medical aspect of the present situation. Addressed D.G.M S. repeated Commanders 3rd and 4th and Advanced Reserve Armies.

From: Adjutant-General,
Advanced G.H.Q.

EXTRACT FROM THE "LONDON GAZETTE," JUNE 23, 1916.

June 26, 1916.

The King has been graciously pleased to give orders for the following promotion in, and appointments to, the Most Honourable Order of the Bath, for services rendered in connexion with military operations in the field. The promotions and appointments to date from June 3, 1916:—

To be additional members of the Military Division of the Third Class, or Companions, of the said Most Honourable Order:—

Col. Frederick William George Gordon-Hall, M.B., Army Medical Service.
Lieut.-Col. Robert John Watt Mawhinny, Royal Army Medical Corps.

Chancery of the Order of Saint Michael and Saint George.

Downing Street,
June 26, 1916.

Temp. Hon. Major Auguste Charles Valadier, Army Medical Service.

War Office,
June 26, 1916.

His Majesty, the King, has been graciously pleased to approve of the undermentioned rewards for Distinguished Service in the Field, dated June 3, 1916.

Awarded the Distinguished Service Order.

Major Robert Tilbury Brown, M.D., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.), Alfred Ernest Conquer Keble, Royal Army Medical Corps.

Awarded the Military Cross.

Temp. Capt. Morton Peto, M.B., Royal Army Medical Corps.
Capt. Joseph Swinburn Townley, Royal Army Medical Corps, Territorial Force.

EXTRACT FROM THE "LONDON GAZETTE" OF JUNE 23, 1916.

June 24, 1916.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers and Warrant Officers, in recognition of their gallantry and devotion to duty in the field:—

Temp. Capt. Frederick Charles Atkinson-Fleming, M.B., Royal Army Medical Corps (attached 8th Battalion Royal Inniskilling Fusiliers).

For conspicuous gallantry and devotion to duty when tending casualties during and subsequent to a hostile attack. He worked without ceasing under difficult and dangerous conditions.

Temp. Lieut. Francis Keene Marriott, Royal Army Medical Corps (attached Headquarters 182nd Field Artillery Brigade).

For conspicuous gallantry and devotion to duty when he went out to tend the wounded of two batteries which were under heavy shell fire.

The undermentioned Officers and Warrant Officers have been awarded the Distinguished Service Order and Military Cross respectively, and the specific acts for which the rewards have been granted will be announced as soon as possible in the *London Gazette*:—

AWARDED THE DISTINGUISHED SERVICE ORDER.

Temp. Capt. Walter Dawson, M.B., Royal Army Medical Corps.

Capt. William Archibald Miller, M.B., Royal Army Medical Corps, Special Reserve (attached 22nd Battalion, Royal Fusiliers).

AWARDED THE MILITARY CROSS.

Temp. Capt. Cyril Mary Brophy, Royal Army Medical Corps (attached 18th Battalion, London Regiment, Territorial Force).

Capt. Arthur Edmund Ironside, 4th London Field Ambulance, Royal Army Medical Corps, Territorial Force.

Temp. Capt. John Moir MacKenzie, M.B., Royal Army Medical Corps (attached 6th Battalion, Northumberland Fusiliers, Territorial Force).

Temp. Lieut. Charles Cyril Okell, No. 6 Field Ambulance, Royal Army Medical Corps.

DISTINGUISHED AND MERITORIOUS SERVICE.

A Good Service Annuity of £50 granted to Col. T. J. R. Lucas, C.B., M.B., retired pay, late Army Medical Service, as a reward for distinguished and meritorious service.

DISTINGUISHED CONDUCT MEDALS.

His Majesty The King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned non-commissioned officers and men for acts of gallantry and devotion to duty in the field.

(Supplement to the *London Gazette* No. 29528 dated March 28, 1916.)

No. 42427 Serjt. W. J. Currie.

No. 38359 Pte. J. J. Fitton.

For conspicuous gallantry. Serjt. Currie and Pte. Fitton succeeded in rescuing from a farm, which was being heavily shelled, seven wounded men, after one man had been killed and another wounded in the attempt.

No. 7830 Pte. R. G. Found.

For conspicuous gallantry. When a trench mortar bomb landed in a thickly manned portion of our trench, he rushed up and pinched the fuse before the other men had time to get into safety. He then poured water on the fuse and flung the bomb over the parapet.

No. 40745 Cpl. D. H. Molyneux.

For conspicuous gallantry during operations, in repeatedly leading stretcher squads through heavy shell fire.

(Supplement to the *London Gazette* No. 29548, dated April 14, 1916.)

No. 37869 Serjt. H. Langley.

For conspicuous gallantry in carry three wounded men across the open under heavy fire into safety. He also evacuated the wounded under very difficult circumstances.

No. 54003 Pte. S. McKenna.

For conspicuous gallantry and devotion to duty. When several attempts had failed to rescue a wounded man from a crater, he succeeded in doing so single-handed. He was heavily bombed in the sap, and for over an hour was unable to move the wounded man. He eventually got him to safety. He returned to the crater and rescued a second wounded man. During the performance of this action he was hit by a bomb. He at once buried it in the mud and it failed to explode. He showed great endurance in carrying these wounded men long distances under most difficult circumstances.

No. 45659 Pte. S. A. Smith.

For conspicuous devotion to duty. Under heavy fire which prevented the use of stretchers, Pte. Smith assisted in carrying wounded men into safety.

(Supplement to the *London Gazette* No. 29602, dated May 30, 1916.)

No. 11702 Pte. A. Hamilton.

For conspicuous gallantry and devotion to duty. During very heavy shell fire he tended thirty to forty wounded men lying in the open, bringing into safety as many as possible. He led stretcher parties to collect isolated cases and set a fine example generally.

(Supplement to the *London Gazette* No. 29631, dated June 20, 1916).

No. 36537 Pte. H. Baulcomb.

For consistent good work and devotion to duty. On one occasion he worked day and night for four consecutive days.

No. 17843 Qmr.-Serjt. R. C. Blair (Acting Serjt.-Maj.).

For conspicuous devotion to duty. On one occasion he remained on duty during operations for ninety-six consecutive hours. He has also been brought to notice for marked bravery.

No. 15537 Staff-Serjt. F. Booth.

For excellent work. He was in charge of an advanced depôt of medical stores for a considerable time, and kept up supplies to troops and hospitals often under shell fire.

No. 46363 Acting Staff-Serjt. E. Fenner.

For consistent good work and devotion to duty.

No. 12344 Serjt. F. H. Lucas.

For conspicuous gallantry and good work as Sanitary Officer in a much shelled area. He has repeatedly shown great pluck, notably when he went to a party of men who had been shelled, rendered first aid, and got the wounded into safety under very heavy shell fire

No. 10431 Serjt.-Major H. Underwood.

For excellent work as Superintending Clerk.

DECORATIONS.

His Majesty the King has been graciously pleased to approve of the undermentioned rewards for Distinguished Service in the Field, dated June 3, 1916.

(Supplement to the *London Gazette* No. 29608 dated June 2, 1916).

Awarded the Military Medal.

No. 46305 Pte. D. B. Anderson, No. 43112 Cpl. T. Clayton, No. 16224 Pte. G. Constable, No. 41531 Cpl. J. J. Davies, No. 17743 Cpl. F. Dress, No. 58261 Pte. G. H. Dunstone, No. 31667 Serjt. R. Eastham, No. 2178 Pte. H. E. Felsted, No. 20192 Pte. F. Fensome, No. 41539 Pte J. Fraser, No. 58330 Cpl A. H. Grimmitt, No. 18504 Pte. W. J. Hall, No. 1683 Pte. H. A. Holt (Acting Lance-Cpl.), No. 36413 Pte. G. Johnson, No. 1116 Serjt. J. W. Lockwood, No. 57944 Serjt. W. Marley, No. 30203 Serjt. M. Nolan, No. 7000 Pte. L. Patterson, No. 15288 Qmr.-Serjt. W. C. Prince, No. 15289 Serjt. H. R. M. Rodman, No. 7273 Pte. T. N. G. Scott, No. 44975 Pte. W. Shandley, No. 49517 Serjt. J. T. Shee, No. 53646 Acting Lance-Cpl. H. J. Simmons, No. 3540 Pte. C. Sims.

MENTIONED IN DESPATCHES.

The names of the following Non-Commissioned Officers of the Royal Army Medical Corps were mentioned in the Despatch from Major-Gen. Sir Charles M. Dobell, K.C.B., Commanding the Allied Forces in the Cameroons, published in the Supplement to the *London Gazette*, No. 29604, dated May 30, 1916 :—

No. 14082 Staff-Serjt. G. Priuce ; No. 1911 Cpl. (Lance.-Serjt.) N. W. J. Turnbull.

The names of the following Non-Commissioned Officer of the Royal Army Medical Corps was mentioned in the Despatch from Brig.-Gen. Cunliffe, C.M.G., on the Military operations in the Northern Cameroons, published in the Supplement to the *London Gazette*, No. 29604, dated May 30, 1916 :—

No. 19029 Serjt. R. E. Harvey (now Staff-Serjt.).

The names of the following Warrant Officers, Non-Commissioned Officers and men were mentioned in the Despatch from General Sir Douglas Haig, G.C.B., Commander-in-Chief of the British Forces in France, published in the Supplement to the *London Gazette*, No. 29623, dated June 13, 1916 :—

No. 83767 Serjt.-Major T. W. Comfort; No. 17933 Serjt.-Major D. E. Dean; No. 16115 Serjt.-Major E. B. Dewberry; No. 14464 Serjt.-Major G. F. Hurran; No. 11613 Serjt.-Major G. R. Morris; No. 14663 Serjt.-Major P. Snow; No. 16265 Serjt.-Major P. T. Simes: No. 12377 Qmr.-Serjt. B. L. Aldhous (Acting Serjt.-Major): No. 13035 Qmr.-Serjt. G. V. Chandler: No. 18969 Qmr.-Serjt. E. Grey (Acting Serjt.-Major), No. 8879 Qmr.-Serjt. W. J. Wells; No. 1094 Staff-Serjt. H. B. Alloway; No. 8510 Qmr.-Serjt. W. H. Butler (Acting Serjt.-Major); No. 56602 Staff-Serjt. E. Evans; No. 10719 Staff-Serjt. W. H. Hopwood: No. 15001 Staff-Serjt. W. Hurst; No. 46215 Qmr.-Serjt. H. Usher. No. 39168 Staff-Serjt. O. Williams, No. 1791 Serjt. P. G. Elsey, No. 954 Serjt. H. C. Hallett, No. 58003 Staff.-Serjt. A. E. Kitchen, No. 19106 Cpl. G. F. Bardwell (Acting Serjt.), No. 1772 Cpl. M. A. Butler, No. 5444 Pte. G. W. Holdup, No. 162 Cpl. H. E. H. Thatcher (Acting Serjt.), No. 58164 Pte. F. Ashby (died of wounds), No. 44205 Pte. C. A. Baxter, No. 58058 Pte. J. Brown, No. 39326 Pte. S. H. Burke, No. 11588 Pte. M. J. Emmett, No. 46887 Pte. A. Freeman, No. 1565 Pte. N. Kinmond, No. 18323 Pte. F. B. Luke, No. 20697 Pte. R. Mooney, No. 765 Cpl. J. Power, No. 1860 Pte. A. J. Wood (Acting Lance.-Cpl.).

The names of the following warrant officers, non-commissioned officers and men were mentioned in the Despatch from General Sir J. C. Maxwell, K.C.B., C.V.O., C.M.G., D.S.O., Commanding the Force in Egypt, published in the Supplement to the *London Gazette* No. 29632, dated June 20, 1916:—

No. 9862 Staff-Serjt. W. F. Raven (Acting Serjt.-Major), No. 15808 Serjt.-Major C. M. Primer, No. 32196 Serjt.-Major A. McNeill, No. 8994 Serjt.-Major C. Kingston, No. 33913 Serjt. A. Guerin (Acting Qmr.-Serjt.), No. 43124 Qmr.-Serjt. A. B. Grindlay, No. 5015 Serjt. R. J. Beisly, No. 1509 Serjt. A. Warren, No. 4310 Serjt. F. H. Tomlyn, No. 57592 Pte. M. Price, No. 9237 Pte. W. J. Gallagher, No. 43167 Pte. J. W. R. Robertson, No. 36799 Pte. F. Carter, No. 36688 Pte. H. J. Williams, No. 17772 Pte. A. Callaghan. No. 41916 Pte. W. Chalkley, No. 36749 Pte. W. J. Allsopp, No. 36592 Pte. G. E. Barlow, No. 47012 Pte. E. Duffy, No. 44943 Pte. H. Hodson, No. 43732 Pte. J. Smith, No. 5854 Pte. W. Newby, No. 6750 Pte. M. Mooney, No. 35177 Pte. G. Sales, No. 5687 Pte. G. Wright, No. 68037 Pte. H. D. Hubbard, No. 28150 Pte. H. W. Johnson.

PROMOTIONS.

The following promotions to complete War Establishment will take effect from the dates specified :—

To be Quartermaster-Serjeants.—No. 9467 Staff-Serjt. C. J. Tunn, dated April 18, 1916; No. 9862 Staff-Serjt. W. F. Raven, dated May 5, 1916; No. 18427 Staff-Serjt. P. Barber, dated May 19, 1916, for Distinguished Service in the field; No. 8682 Staff-Serjt. G. Read, dated May 20, 1916; No. 10011 Staff-Serjt. J. H. Taylor, dated June 6, 1916; No. 10333 Staff-Serjt. T. Martin, dated June 6, 1916; No. 8137 Staff-Serjt. T. French, dated June 6, 1916; No. 10953 Staff-Serjt. W. H. Way, dated June 6, 1916; No. 10087 Staff-Serjt. E. Canterbury, dated June 14, 1916; No. 8903 Staff-Serjt. J. Robson, dated June 15, 1916; No. 11812 Staff-Serjt. W. C. Banks, dated June 24, 1916.

To be Serjeants.—No. 4928 Cpl. H. R. Mack, dated April 12, 1916, special as clerk; No. 19280 Cpl. E. Clarke, dated April 17, 1916; No. 19289 Cpl. F. J. Mills, dated April 25, 1916; No. 20413 Cpl. D. Burch, dated May 24, 1916.

To be Corporals.—No. 7830 Pte. R. G. Found, dated April 12, 1916; No. 13654 Pte. F. Clapton, dated April 16, 1916; No. 19248 Pte. J. R. Hunt, dated April 17, 1916; No. 1891 Pte. H. J. Rance, dated April 20, 1916; No. 5396 Pte. J. H. Thompson, dated April 25, 1916; No. 6156 Pte. D. C. Blake, April 30, 1916; No. 7249 Pte. H. L. G. Buckingham, dated May 2, 1916; No. 18284 Pte. F. Martin, dated May 14, 1916; No. 14746 Pte. J. R. Smith, dated May 24, 1916; No. 11702 Pte. A. Hamilton, dated June 1, 1916.

These promotions are subject to the conditions laid down in paragraph 35 Standing Orders, R.A.M.C., 1914.

AWARD OF ARMY FORM C.344.

The undermentioned have been awarded Army Form C. 344 on completion of three years' training, in accordance with paragraph 330 Standing Orders, on the dates specified:—

No. 6218 Cpl. A. W. Cockerell, dated May 1, 1916; No. 5048 Pte. J. W. P. Suter, dated May 2, 1916.

NURSING SECTION.

The following appointments to the Nursing Section of the Corps will take effect from the dates specified:—

No. 10225 Pte. E. Sellens, dated April 11, 1916; No. 10396 Pte. G. Cullwick, dated April 11, 1916; No. 3737 Pte. A. Anderson, dated April 17, 1916; No. 6642 Pte. P. T. Beaumont, dated April 17, 1916; No. 7512 Pte. A. R. Tait, dated April 17, 1916; No. 653 Pte. J. Welsh, dated April 17, 1916; No. 10145 Pte. W. Chapman, dated April 17, 1916; No. 6406 Pte. T. J. Reid, dated April 17, 1916; No. 7255 Pte. C. Edgeley, dated April 17, 1916; No. 2540 Pte. V. A. Brock, dated April 17, 1916; No. 521 Serjt. G. O. Triebwasser (Supernumerary), dated March 22, 1916; No. 19528 Pte. F. A. Stiff, dated April 22, 1916; No. 5076 Cpl. F. H. Phillips, dated April 9, 1916; No. 2321 Pte. E. Burgess, dated April 25, 1916; No. 6558 Pte. P. Peters, dated April 26, 1916; No. 7384 Pte. G. A. Beratta, dated April 26, 1916; No. 6656 Pte. A. J. Elv'e, dated April 26, 1916; No. 1409 Pte. B. M. Palmer, dated April 26, 1916; No. 4360 Pte. H. C. Pinner, dated April 26, 1916; No. 573 Pte. F. E. Antcliff, dated April 26, 1916; No. 2902 Pte. A. Bradshaw, dated April 26, 1916; No. 11871 Pte. H. G. Craig, dated April 26, 1916; No. 10803 Pte. E. Whiles, dated April 26, 1916; No. 4771 Pte. W. J. Watkins, dated April 26, 1915; No. 3054 Pte. H. Lewis, dated April 26, 1916; No. 10670 Pte. J. E. Prior, dated April 26, 1916; No. 20636 Pte. R. W. Davison, dated April 26, 1916; No. 2067 Pte. A. Glover, dated April 27, 1916; No. 7740 Pte. A. Rogers, dated April 27, 1916; No. 12320 Pte. S. Wells, dated April 27, 1916; No. 10893 Pte. H. M. Horwell, dated May 1, 1916; No. 2107 Pte. W. H. Boorman, dated May 1, 1916; No. 19400 Cpl. H. W. Jackson, dated May 1, 1916; No. 7774 Pte. B. G. Sellars, dated May 1, 1916; No. 5690 Pte. H. E. Breese (re-appointed), dated May 1, 1916; No. 565 Pte. J. T. Robson, dated May 1, 1916; No. 6650 Pte. J. Sharp, dated May 1, 1916; No. 10649 Pte. H. A. L. Bickham, dated May 1, 1916; No. 10695 Pte. R. Holt, dated May 1, 1916; No. 7348 Pte. R. H. Warrell, dated May 2, 1916; No. 6510 Pte. A. H. White, dated May 2, 1916; No. 7523 Pte. G. Harris, dated May 2, 1916; No. 7537 Pte. J. Bryers, dated May 2, 1916; No. 2662 Pte. R. E. Conway, dated May 4, 1916; No. 7668 Pte. E. S. Dyer, dated May 4, 1916; No. 3919 Pte. W. Harriman, dated May 5, 1916; No. 19549 Pte. A. H. Chambers (re-appointed) dated May 8, 1916; No. 7764 Pte. N. Cartwright, dated May 8, 1916; No. 8577 Pte. J. Lenny, dated May 9, 1916; No. 10478 Pte. B. Fairbrother, dated May 9, 1916; No. 10488 Pte. O. Lodge, dated May 9, 1916; No. 10426 Pte. T. Way, dated May 9, 1916; No. 10439 Pte. F. Callaghan, dated May 9, 1916; No. 10516 Pte. J. Hodgson, dated May 9, 1916; No. 10492 Pte. H. Maddox, dated May 9, 1916; No. 10499 Pte. J. Webster, dated May 9, 1916; No. 7816 Pte. B. O'Neill, dated May 11, 1916; No. 10024 Pte. J. H. Lowes, dated May 11, 1916; No. 1008 Pte. A. J. Carey, dated May 11, 1916; No. 4979 Pte. H. R. Dunbar, dated May 11, 1916; No. 4351 Pte. W. G. Rodber, dated May 11, 1916; No. 4930 Pte. T. Ware, dated May 11, 1916; No. 1006 Pte. G. Gibson, dated May 23, 1916; No. 5295 Pte. H. Desperques, dated May 24, 1916; No. 4394 Pte. J. M. Hird, dated May 29, 1916; No. 5724 Pte. A. G. T. Brown, dated May 29, 1916; No. 11585 Pte. F. J. Cattell, dated May 29, 1916; No. 11475 Pte. J. Keogh, dated May 29, 1916; No. 7935 Pte. T. Green, dated May 31, 1916; No. 11992 Pte. J. Kelly, dated May 31, 1916; No. 5879 Pte. A. G. A. Mines, dated May 31, 1916; No. 6762 Pte. T. Tomlin, dated May 31, 1916; 5132 Pte. G. H. MacFarlane, dated June 2, 1916; No. 4639 Pte. F. Beesley, dated June 9, 1916; No. 7913 Pte. T. Beale, dated June 9, 1916; No. 3832 Pte. W. Commons, dated June 9, 1916; No. 5615 Pte. A. G. Cook, dated June 9, 1916; No. 4056 Pte. G. Lambert, dated June 9, 1916; No. 6036 Pte. L. F. North, dated June 9, 1916; No. 15899 Pte. H. G. Piper, dated June 9, 1916; No. 4576 Pte. R. Davies, dated June 9, 1916; No. 20134 Pte. H. J. Fisher, dated June 12, 1916; No. 7900 Pte. L. F. McIntosh, dated June 12, 1916; No. 10019 Pte. H. Sneddon, dated June 12, 1916; No. 10063 Pte. F. Chesterman, dated June 12, 1916; No. 10095 Pte. J. Larner, dated June 12, 1916; No. 6465 Pte. C. Todd, dated June 12, 1916; No. 10068 Pte. E. Fox, dated June 12, 1916; No. 10117 Pte. J. Elliott, dated June 12, 1916; No. 10017 Pte. J. Manson, dated June 12, 1916; No. 10070 Pte. D. B. Gibb, dated June 12, 1916;

No. 5391 Pte. J. Hedley, dated June 12, 1916; No. 5923 Pte. J. T. Deakins, dated June 12, 1916; No. 12593 Pte. J. Hewitt, dated June 12, 1916; No. 1442 Pte. S. E. Minns, dated June 12, 1916; No. 7585 Pte. G. Thomas, dated June 12, 1916; No. 7582 Pte. W. F. Wilson, dated June 12, 1916; No. 12366 Pte. W. H. Wildey, dated June 13, 1916; No. 15999 Pte. A. Bye, dated June 13, 1916; No. 16149 Pte. J. Milroy, dated June 13, 1916; No. 3041 Pte. F. Tanner, dated June 13, 1916; No. 11226 Pte. P. J. Kewell, dated June 13, 1916; No. 10773 Pte. J. Ashley, dated June 15, 1916; No. 5967 Pte. P. J. Hill, dated June 19, 1916; No. 1595 Pte. J. Goodrick, dated June 19, 1916; No. 8437 Pte. J. G. Harrison, dated June 19, 1916; No. 20013 Pte. J. Dawson, dated June 19, 1916; No. 5606 Pte. O. B. Finch, dated June 19, 1916; No. 2715 Pte. T. Galt, dated June 19, 1916; No. 20810 Pte. H. Hunt, dated June 19, 1916; No. 4046 Pte. C. A. Cowin, dated June 19, 1916; No. 10395 Pte. E. H. Bullough, dated June 22, 1916; No. 10821 Pte. J. J. Dilbey, dated June 22, 1916; No. 10747 Pte. P. Hackett, dated June 22, 1916; No. 10792 Pte. W. Lane, dated June 22, 1916; No. 10410 Pte. T. Morris, dated June 22, 1916; No. 10797 Pte. J. A. Robinson, dated June 22, 1916; No. 10906 Pte. W. Stott, June 22, 1916; No. 10421 Pte. F. H. Todd, dated June 22, 1916; No. 11023 Pte. A. Gardner, dated June 26, 1916; No. 10696 Pte. G. H. Hale, dated June 26, 1916; No. 12389 Pte. W. Lacey, dated June 26, 1916; No. 10834 Pte. J. Neary, dated June 26, 1916; No. 1310 Pte. A. F. Purdy, dated June 26, 1916; No. 11921 Pte. L. Bridges, dated June 27, 1916; No. 11933 Pte. E. Hassett, dated June 27, 1916; No. 12647 Pte. T. Norris, dated June 27, 1916; No. 12601 Pte. F. Padley, dated June 27, 1916; No. 12579 Pte. H. A. Perkins, dated June 27, 1916; No. 10129 Pte. J. C. Simpson, dated June 28, 1916.

ADVANCEMENT OF PRIVATES (CORPS PAY).

The following advancements in rate of Corps Pay will take effect from the dates specified:—

To be Advanced to the Third Rate (at 8d.) from April 10, 1916.

As Orderly.—No. 2186 H. E. Jenkins.

To be Advanced to the Third Rate (at 8d.) from June 28, 1916.

As Orderlies.—No. 4430 J. Adderley, No. 3002 J. Faram, No. 6552 W. Craib, No. 2040 J. H. Freeston, No. 19974 J. Wainwright, No. 6884 J. Griffin, No. 2088 J. Clarke, No. 5253 J. A. Kelsey, No. 1745 L. F. Songhurst, No. 14456 J. Robinson, No. 28 J. Bracken, No. 18652 T. Playle, No. 3109 S. Rice, No. 5202 J. W. Hayter, No. 2555 T. Molloy, No. 10679 L. A. Upfold, No. 17797 H. F. Scott, No. 19487 E. Devall, 19868 A. E. Harris, No. 19797 A. J. Hughes, No. 5532 F. E. Lawrence, No. 5786 F. Burgess, No. 17494 F. Peckham, No. 2779 G. H. Williams, No. 7220 F. S. Shipley, No. 10066 A. Clarkson, No. 19290 A. E. Horlock, No. 5698 J. Brownlie, No. 2074 C. Bowen, No. 151 G. A. T. Dashfield, No. 20850 P. Thomas, No. 5066 T. Brown, No. 5312 R. G. Slater, No. 6461 G. W. Chapman, No. 14896 R. Ritchie, No. 5937 F. A. Withers, No. 6363 L. M. Herbert, No. 7390 C. Orme, No. 6331 W. E. H. C. Fairfield, No. 7707 E. E. Sheppard, No. 7246 T. Hickey, No. 18056 E. Yates, No. 14901 J. W. H. Smith, No. 14388 J. Astley, No. 17407 H. Howard, No. 7386 W. Dunn.

As Clerks.—No. 7085 H. G. Goodall, No. 4834 R. L. Keating, No. 8443 W. T. Herrick.

As Cooks.—No. 16162 A. C. Rose, No. 17212 F. Haskell.

To be Advanced to the Fourth Rate (at 6d.) from June 28, 1916.

As Orderlies.—No. 6767 W. Duggan, No. 10345 S. Eastwood, No. 7825 D. Morrison, No. 4496 H. H. Brown, No. 16149 J. Milroy, No. 5812 J. Duncan, No. 6760 W. Paull, No. 19840 A. E. Haynes, No. 12642 W. Mellors, No. 6860 A. W. Brooks, No. 7273 T. N. G. Scott, No. 7154 T. Simmonds, No. 2038 M. Neville, No. 7243 H. Baxter, No. 11371 F. L. Crow, No. 17006 R. Mair, No. 10790 A. B. Langley, No. 8757 F. A. Noon, No. 9135 P. Hanson, No. 4388 D. P. Humphris, No. 8924 C. Jones, No. 7400 J. Boura, No. 10225 E. Sellens, No. 4531 W. G. Rodber, No. 20438 T. Stenhouse, No. 10893 H. M. Howell, No. 2107 W. H. Boorman, No. 7774 B. G. Sellars, No. 5690 H. E. Breeze, No. 6650 J. Sharp, No. 4930 T. Ware, No. 9773 L. F. Turner, No. 10491 A. Martin, No. 10652 F. H. Browne, No. 12436 R. W. H. Beaumont, No. 1006 G. Gibson, No. 19187 C. V. Hunt, No. 5295 H. Desperques, No. 1067 R. L. Laversuch, No. 9112 F. J. G. Spain, No. 9115 W. T. Blewitt, No. 10396 G. Cullwick, No. 3699 G. H. Cotterell, No. 6967 C. Cross, No. 3724 R. McEvoy, No. 5919 E. F. Newman, No. 7536 A. Pooley, No. 6642 P. T. Beaumont, No. 7512 A. R. Tait, No. 653 J. Welsh,

No. 6406 T. J. Reid, No. 1887 C. Wood, No. 4354 A. Bowman, No. 19717 H. Collins, No. 7625 W. G. P. Stallard, No. 2540 V. A. Brock, No. 4471 R. Clarke, No. 2554 W. McKeown, No. 3525 E. Wright, 3110 E. Newman, 5152 H. A. Spencer, No. 2321 E. Burgess, 6558 P. Peters, No. 3811 E. Ilott, No. 20051 F. Moore, No. 4394 J. M. Hird, No. 5724 A. G. T. Brown. No. 11585 F. J. Cattell, No. 11475 J. Keogh, No. 7764 N. Cartwright, No. 19549 A. H. Chambers, No. 2203 P. Beirne, No. 6032 G. K. Coad. No. 2966 S. A. Hodgetts, No. 6525 F. W. T. Hurley, No. 12554 J. Lloyd, No. 5234 H. St. J. Mills, No. 5558 J. C. Vickers, No. 10475 J. Baggot, No. 1334 J. T. Austin, No. 1737 R. Glenton, No. 1807 W. J. Cahill, No. 7291 G. W. Dumbrell, No. 3845 W. Hewitt, No. 5153 T. Cole, No. 19831 R. C. Gale, No. 12320 S. Wells, No. 5779 J. Murphy, No. 11871 H. G. Craig, No. 8936 F. C. Jackson, No. 1471 E. A. Cove, No. 7348 R. H. Warrell, No. 6510 A. H. White, No. 7160 S. Gale, No. 7523 G. Harris, No. 7537 J. Bryers, No. 6969 J. Harle, No. 7848 A. Hutt, No. 6933 C. Kitchen, No. 7668 E. S. Dyer, No. 10024 J. H. Lowes, No. 7816 B. O'Neil, No. 1008 A. J. Carey, No. 4979 H. R. Dunbar, No. 4081 P. F. O'Brien, No. 9572 J. L. Thomson, No. 5132 G. H. McFarlane. No. 7230 E. Berry, No. 7284 C. J. Skilton, No. 2267 F. W. Parsons, No. 20134 H. J. Fisher, No. 7582 W. F. Wilson, No. 12366 W. H. Wildey, No. 11226 P. J. Kewell, No, 4390 T. Barlow, No. 4159 T. A. Howell, No. 10764 C. Shelton, No. 7626 J. M. Barnett, No. 7623 E. Hands, No. 7644 F. Sandever, No. 732 E. Bountiff.

These advancements are subject to the conditions laid down in paragraph 35 Standing Orders for the Royal Army Medical Corps, 1914.

SANITARY ORDERLIES.

The following Privates are advanced to the fourth rate of Corps Pay at 6d. as Sanitary Orderlies from the dates specified :—

No. 20746 G. Stubbs, dated May 5, 1916; No. 9388 H. G. Hartwell, dated May 5, 1916; No. 5009 T. H. Eales, dated May 9, 1916.

BUGLERS.

The undermentioned boy was appointed Bugler from the date specified :—

No. 9927 S. D. Robinson, dated October 6, 1914.

REPOSTING TO CORPS.

The undermentioned Non-commissioned Officers rejoined the Corps on the dates specified :—

No. 11440 Staff-Serjt A. Farmer, from Territorial Force, April 7, 1916; No. 10327 Staff-Serjt. J. C. Carder, from Territorial Force, April 20, 1916; No. 18577 Qmr.-Serjt F. L. Reid, from Colonial Government, April 27, 1916; No. 12411 Staff-Serjt. A. A. Sims, from Colonial Government, June 19, 1916.

AMENDMENTS—CORPS ORDERS.

Decorations.

In Corps Order dated April 10, 1916, under the heading "Médaille Militaire" for "No. 88662 Driver E. Smith, R.F.A., formerly No. 36288 R.A.M.C.," read "No. 54989 Serjt. Smith, E."

Promotion Cancelled.

The promotion to the rank of Corporal of No. 325 Pte. J. Clark, notified in Corps Order dated April 10, 1916, is hereby cancelled.

Advancements—Corps Pay Cancelled.

In Corps Order dated April 10, 1916, the advancement to the 4th rate of Corps Pay as Orderly of No. 7637 Pte. J. T. Dexter is hereby cancelled.

Non-European Section R.A.M.C.—Advancement of Privates (Corps Pay).

The following advancements in rate of Corps Pay will take effect from June 28 1916 :—

To be advanced to the Fourth Rate (at 6d.).

As Orderlies.—No. 3 E. Berton, No. 19 R. Campbell.

ROYAL ARMY MEDICAL COLLEGE.

LIST OF BOOKS ADDED TO THE LIBRARY DURING THE MONTHS OF APRIL, MAY AND JUNE, 1916.

Title of Work and Author	Edition	Date	How obtained
Water Purification Plants and their Operation. By Milton F. Stein		1915	Library Grant.
The Elements of Military Hygiene. By P. M. Ashburn		1914	,, ,,
Papers by Officers of the Medical Corps, U.S. Army, read before the 15th International Congress of Hygiene and Demography, Washington, 1912		1912	,, ,,
Annual Report of the Surgeon-General of the Public Health Service of the United States for the Fiscal year 1915		1915	Editor, Journal.
The Effects of High Explosives upon the Central Nervous System. By Major F. W. Mott, M.D., F.R.S., R.A.M.C.(T.)		1916	,, ,,
Cerebrospinal Fever. By Foster and Gaskell ..		1916	,, ,,
Proceedings of the Medical Association of the Isthmian Canal Zone, for the Half-year October, 1914, to March, 1915. Vol. vii. Part 2		1916	,, ,,
Reports to the Local Government Board on Public Health and Medical Subjects. New Series. No. 110. Reports on Cerebrospinal Fever		1916	,, ,,
Victoria Department of Public Health. Cerebrospinal Meningitis. Report of the Departmental Medical Committee, December, 1915		1916	,, ,,
The International Military Digest. Annual for 1915		1916	,, ,,
Handbook of the French Army, 1914		1914	Commandant's Office.
Exposition Universelle et Internationale de San Francisco. La Science Française. 2 vols		1915	Commandant's Office.
Kriegschirurgische Hefte der Beiträge zur Klinischen Chirurgie. Band xcvi, Heft 4; Band xcvii, Hefts 1 to 5; Band xcviii, Hefts 1 to 5		1915-16	Director-General, A.M.S.
Report of the Surgeon-General United States Army to the Secretary of War, 1915		1915	War Office.
Lister Institute of Preventive Medicine. Report for 1916		1916	,, ,,
Kriegschirurgische Tatigkeit. Von Prof. Dr. L. Dreyer		1916	,, ,,
Die Willkürlich bewegbase Küustliche Hand. Von F. Sauerbruche		1916	,, ,,
Die Immunitätslehre und Cleren praktische, &c. Von Med. Dr. A. Forbat		1916	,, ,,
The Fauna of British India: Rynchota, vol. vi. Homoptera. Appendix. By W. L. Distant		1916	Secretary of State for India in Council.
Year Book of the Royal Society		1916	Royal Society.
A Monograph of the Tsetse Flies. By E. E. Austen		1903	Presented by Surgeon-General Sir D. Bruce, C.B., F.R.S.

Lieut.-Col. Sir J. Fayrer, Bt., M.D., R.A.M.C. (retired), and Major F. D. S. Fayrer, I.M.S., have most generously presented to the library of the Royal Army Medical College a very large number of books from the library of the late Sir Joseph Fayrer, Bt., K.C.S.I., M.D., F.R.S. The list comprises medical and other works of great value and interest, and will be highly appreciated by all the officers of the Royal Army Medical Corps.

ROYAL ARMY MEDICAL CORPS OFFICERS' BENEVOLENT SOCIETY.

PROCEEDINGS OF A COMMITTEE MEETING HELD AT THE WAR OFFICE ON FRIDAY, JULY 14, AT 3 P.M., IN ROOM 357.

Present.

Surg.-Gen. M. W. Russell, C.B., in the Chair.
Surg.-Gen. Sir David Bruce, C.B., F.R.S.
Col. J. Stevenson.
Lieut.-Col. E. M. Wilson, C.B., C.M.G., D.S.O.
Lieut.-Col. E. M. Pilcher, D.S.O.
Lieut.-Col. A. B. Cottell.

(1) The Minutes of the last Meeting were read and confirmed.

(2) It was noted that a further donation of £25 has been received from the Medical Insurance Agency, and that a letter of thanks from this Committee has been sent.

(3) With reference to the resolution embodied in Minute 8 of the last Annual General Meeting regarding the division of the combined working expenses of this Society and the Royal Army Medical Corps Fund, it was resolved: "That from January 1, 1917, this Society shall contribute one-third of the working expenses, the Royal Army Medical Corps Fund having agreed to pay the other two-thirds of the combined working expenses.

(4) It was noted that the sum of £60 10s., being donations earmarked for the orphans of Officers holding temporary commissions in the Royal Army Medical Corps, has been transferred to the Officers' Benevolent Branch of the Auxiliary Royal Army Medical Corps Funds, in accordance with Minute 7 of the Annual General Meeting.

(5) An application for a grant from the orphan daughter of Lieut.-Col. A. T. was considered. The orphan submitted a medical certificate that she is blind in both eyes. It was resolved that she be given a grant at once of £20.

July 15, 1916. F. W. H. DAVIE HARRIS, *Lieut.-Col., Secretary.*

ROYAL ARMY MEDICAL CORPS FUND.

PROCEEDING OF A COMMITTEE MEETING HELD AT THE WAR OFFICE ON FRIDAY, JULY 14, 1916, AT 2.30 P.M., IN ROOM NO. 357.

Present.

Surg.-Gen. M. W., Russell, C.B., in the Chair.
Surg.-Gen. Sir David Bruce, C.B., F.R.S.
Lieut.-Col. E. M. Wilson, C.B., C.M.G., D.S.O.
Lieut.-Col. E. M. Pilcher, D.S.O.
Lieut.-Col. G. St. C. Thom.
Major W. Ward.

(1) The Minutes of the last Meeting were read and confirmed.

(2) It was noted that £616 18s. 4d. has been received, in grants, from Units, for the General Relief Fund, during the past quarter. A detailed list of contributions is attached hereto.

(3) Sanction was given for the following grants which have been made from the General Relief Fund during the quarter ending June 30, 1916 :—

LIST OF RECIPIENTS FROM THE GENERAL RELIEF FUND FOR THE QUARTER ENDING JUNE 30, 1916.

No.	Name	Age	District	Grant	Total	Remarks
481	Mrs. C. G.	—	Aldershot	£2	£4	Towards Hospital stoppages for confinement. Husband totally disabled. Three children.
482	Mr. G. G.	47	Aldershot	4	22	Blind. No occupation. Wife paralysed.
483	Mr. M. Q.	44	Aldershot	4	8	Unable to work owing to ill-health.
484	Mrs. G. C.	36	London	4	4	Husband lately deceased. Three children.

(4) It was noted that the additional £100, voted by the Annual General Meeting towards the expenses of the Band, has been paid.

(5) The following resolution passed by the Annual General Meeting of the Royal Army Medical Corps Officers' Benevolent Society was considered :—

THE ROYAL ARMY MEDICAL CORPS.

BAND FUND.

Quarter ending June 30, 1916.

RECEIPTS.

	£	s.	d.
By Balance at this date as per Pass Book	26	7	6
,, ,, ,, ,, Petty Cash	2	0	7½
,, Subscriptions, R.A.M.C., Officers, Aldershot, March	3	7	0
,, ,, ,, ,, ,, April	3	5	0
,, ,, ,, ,, ,, May	3	0	0
,, ,, per Messrs. Holt & Co.'s list ..	6	5	0
,, ,, Sir J. R. O. Clark	0	5	0
,, R.A.M.C. Training Centre, Crookham	10	10	0
,, Enteric Depot, Woldingham, Refund of Expenses	9	19	0
,, R.A.M.C. Fund	50	0	0
,, ,, ,, ...	100	0	0
,, Balance of Petty Cash	0	0	0½
	£214	19	2

EXPENDITURE.

	£	s.	d.
To Bandmaster's Salary, quarter ending June 30, 1916	30	0	0
,, Bugler-Serjt. Smith's Salary, quarter ending June 30, 1916	4	12	0
,, Pay to Band, quarter ending June 30, 1916	20	12	0
,, Band Fares ,, ,, ,, ...	4	14	0
,, Messrs. Gale and Polden, quarter ending June 30, 1916	0	10	6
,, Storeman, quarter ending June 30, 1916	0	10	0
,, Repairs to Instruments	1	9	4
,, Postages for Quarter	0	1	4
,, Balance in hand, per Pass Book	152	10	0
	£214	19	2

July 4, 1916.

Audited and found correct,

H. BLAKE, *Captain, R.A.M.C., President.*
F. LAING, ,, ,, } *Members.*
H. BEDINGFIELD, ,, ,,

"That in the opinion of this Society the present division of the combined working expenses of the Royal Army Medical Corps Fund and the Royal Army Medical Corps Officers' Benevolent Society is not equitable, that representation should be made to the Royal Army Medical Corps Committee on the subject, proposing that the Royal Army Medical Corps Fund should pay two-thirds and the Benevolent Society one-third of such expenses."

After considerable discussion on the subject it was resolved on the proposal of Lieut.-Col. E. M. Pilcher, seconded by Surg.-Gen. Sir David Bruce, "That the proposal of the Royal Army Medical Corps Officers' Benevolent Society be adopted from January 1 next, and that this Fund should bear two-thirds of the combined working expenses from that date."

(6) A letter was read from the Bankers saying that the investments set out in Minute 7 of the last Committee Meeting have been made.

(7) The Band Accounts were considered and passed, and are attached to these Proceedings.

(8) The sum of £60 for the General Relief Fund, which was shown in the list of contributions for the quarter ending March 30 last, as received from Lichfield, was given by the Central Hospital, Lichfield.

(9) Lieut.-Col. Wilson proposed the following Resolution which was seconded by Lieut.-Col. Pilcher: "That the maximum grant that may be given from the General Relief Fund be raised from £4 to £6 in six months." Col. Wilson said that he considered that a sum of £4 was not enough to meet some cases of distress, such as from death for funeral expenses, whereas £6 would be, also in some cases of illness. He thought that for ordinary cases of relief £4 was sufficient, but there were other cases when it was not. The Resolution was adopted.

July 15, 1916. F. W. H. Davie Harris, *Lieut.-Col.*, *Secretary.*

GENERAL RELIEF FUND.

Contributions received during the quarter ending June 30, 1916.

No. 1	Cavalry Field Ambulance	£4	10	0
,, 5	Field Ambulance	41	0	0
,, 7	Cavalry Field Ambulance	5	0	0
,, 23	Field Ambulance	10	10	0
,, 28	,, ,,	6	12	8
,, 71	,, ,,	5	0	0
,, 80	,, ,,	4	0	0
,, 102	,, ,,	5	0	0
,, 22	Casualty Clearing Station	12	6	0
,, 23	,, ,, ,,	2	0	0
,, 28	,, ,, ,,	10	0	0
,, 31	,, ,, ,,	4	18	0
,, 33	,, ,, ,,	10	16	6
,, 6	General Hospital	2	2	0
,, 18	,, ,,	2	5	0
,, 21	,, ,,	10	5	0
,, 22	,, ,,	14	8	3
,, 28	,, ,,	5	0	0
,, 14	Stationary Hospital	1	0	0
,, 20	,, ,,	8	15	0
,, 21	,, ,,	10	0	0
,, 41 and 42	Ambulance Trains	3	7	1
,, 19	Company R.A.M.C., Chester	23	13	3
,, 27	,, ,, Hong-Kong	5	0	0
R.A.M.C., Eastbourne		1	13	0
,, Sheffield		5	5	0
,, 5th Division		31	9	2
,, Northern Command		200	0	0
,, St. Andrew's Hospital, Malta		12	2	0
,, Fund		80	0	0
Proceeds of Concert, Llandrindod Wells		12	12	9
,, of Football Match, Aldershot		66	7	8
		£616	18	4

ROYAL MEDICAL BENEVOLENT FUND.

11, Chandos Street,
Cavendish Square,
London, W.
July 3, 1916.

TO THE EDITOR OF "THE JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."

DEAR SIR,—The Royal Medical Benevolent Fund, the Great Benevolent Society of the medical profession, is sorely in want of money now.

Though in ordinary times the medical profession supports its own poor, in these War times this is no longer possible. At the May meeting the Committee had a balance of only £17 in hand, and at the June meeting was faced with a deficit of £16. The demands were heavy and had to be met, and this could only be done by withdrawing £500 from the bank.

As the direct outcome of the War, not only are the ordinary cases of poverty greatly increased in number, but an entirely new class of case has arisen urgently requiring relief, in which without actual poverty there is great temporary distress—distress, however, which it is hoped will relieve itself soon after the War is over and the doctors serving return to their civil duties.

At the outbreak of war, the medical profession responded freely to the Nation's call. The Territorial medical officers were at once called out, and other medical men volunteered. Both alike had to leave their practice at very short notice, and often without being able to make adequate provision for its continuance and maintenance during their absence. Their pay went but little way to supply the loss which their absence entailed, for the working expenses of the practice could not be materially reduced. The result was that many families found themselves in very straitened circumstances. Rent, rates and insurance brook no delay, but, worst of all, school bills could not be paid, and if help had not been quickly forthcoming, the children would have suffered for the patriotism of their father.

The following are typical of the cases with which our Fund has had to deal:—

A young doctor who had only been in practice a few years, volunteered for Service, and was killed in action a few days later. He left a widow, aged 35, with two young boys, aged 3½ and 1 year, entirely without means. The Fund voted £25 for her immediate necessities, and put her into communication with the Officers' Families Association which gave further help.

A practitioner, aged 38, earning £700 to £800, volunteered for Service, leaving his practice in the hands of a neighbour who was not a success. There were two young children, and another baby was born shortly after the husband left. The wife contracted pneumonia and nearly died. A resident patient had to leave the house. Rent and other expenses led to a debt of about £80. This the doctor could not meet, and he hurried back from the trenches to save his home from being sold up. The Fund voted £25, the Guild gave £15, the Officers' Families Association £25, and the Professional Classes War Relief Council further help, with the result that he returned to the front with his immediate anxieties relieved.

A Captain in the Territorials was called out and had to leave his practice in the hands of a Locum who proved a failure. There were seven children, aged 2 to 14. Financial difficulties arose and payment of the school fees became impossible. Between the Fund and Guild, and Officers' Families Association, the necessary fees were raised, and clothing which was greatly required provided.

These cases show well the way in which the Fund works, not only by giving relief itself in money and kind, but also by obtaining through co-operation with other benevolent societies, more substantial assistance than it could afford alone.

But there is another class in which the distress is perhaps even greater and adequate relief more difficult. It is that of men who left home and a good practice in vigorous health and who have come back, crippled by wounds or with health impaired, to a practice severely damaged by their absence, and without the strength or energy to regain the practice and position which they sacrificed.

Our Fund has set apart a special sum to meet emergency claims of this kind, yet the demands are so great that it will soon be exhausted. We cannot now rely on the profession alone to supplement it largely, for the Medical Profession, like all other professions, is hit very hard by the War, and has no longer its old resources to draw upon.

What is required is an emergency fund, large enough to deal adequately with these emergency cases arising directly out of the war, and for this we are driven to appeal to the public as well as to our own profession.

We trust that our appeal will meet with a liberal response both from the public and from the medical profession, for unless fresh funds are quickly forthcoming, it will be impossible to continue the relief which is so urgently required.

We are,

Faithfully yours,

JOHN TWEEDY, *President*,
SAMUEL WEST, *Hon. Treasurer*.
G. NEWTON PITT, *Hon. Secretary*.

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, *Serle Street, London, W.C., not later than the* 22*nd of the month.*

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, and Proceedings of the United Services Medical Society.

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		£ s. d.	£ s. d.	s. d.	s. d.	s. d.	s. d.
12	4	0 2 9	0 1 2				
	8	0 5 0	0 2 3	4 3	1 1	3 10	0 9
	16	0 8 3	0 3 11				
25	4	0 3 4	0 1 5				
	8	0 6 0	0 2 9	4 10	1 6	4 4	0 11
	16	0 10 6	0 5 0				
50	4	0 4 6	0 1 10				
	8	0 7 6	0 3 6	6 0	2 1	4 10	1 2
	16	0 13 3	0 5 10				
100	4	0 6 0	0 3 1				
	8	0 10 0	0 4 10	7 10	3 11	6 7	2 5
	16	0 18 6	0 7 6				
200	4	0 9 6	0 4 5				
	8	0 15 0	0 6 7	10 10	7 6	9 0	4 10
	16	1 6 0	0 9 8				

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G. STREET & CO., Ltd., 8, Serle Street, London, W.C.

The back outside cover is not available for advertisements.

The above figures are subject to 15 per cent. increase.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

All such Communications or Articles accepted and published in the "Journal of the Royal Army Medical Corps" will (unless the Author notifies at the time of submission that he reserves the copyright of the Article to himself) become the property of the Library and Journal Committee, who will exercise full copyright powers concerning such Articles.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W.

Communications have been received from Colonels C. A. Ballance, C. S. Wallace, C.M.G.; Lieutenant-Colonels F. E. Fremantle, P. Sargent, G. Holmes, A. Primrose; Majors J. M. Atkinson, C. A. Duggan, F. W. W. Dawson, A. Don, E. S. Ryerson; Captains A. Stokes, J. A. Ryle, E. Glynn, F. B. Gurd, E. B. Cunson, J. Parkinson, H. V. Drew, A. D. Haydon, T. G. Moorhead, C. H. Shearman, W. Garton, R. G. Abercrombie, N. P. L. Lumb; Lieutenant J. Vickers; R. T. Leiper, D.Sc., M.B.

The following publications have been received:—

British: The Practitioner, The Royal Engineers' Journal, The Indian Journal of Medical Research, Guy's Hospital Gazette, The Hospital, The Medical Journal of South Africa, Transactions of the Society of Tropical Medicine and Hygiene, The Journal of Tropical Medicine and Hygiene, The Lancet, The Medical Review, The Medical Press and Circular, Red Cross and Ambulance News, St. Bartholomew's Hospital Journal, Tropical Diseases Bulletin, Tropical Veterinary Bulletin, The Medical Journal of Australia, The Indian Medical Gazette, The Journal of State Medicine, The Army Service Corps Journal, Public Health, The British Journal of Surgery, The Middlesex Hospital Journal, R.A.M.C. Depot Magazine, The St. Thomas's Hospital Gazette, The Journal of Infectious Diseases.

Foreign: Revista de Sanidád Militar, Memorias do Instituto Oswaldo Cruz, Norsk Tidsskrift fur Militaermedicin, l'Ospedale Maggiore, Russian Naval Medical Journal, Bulletin de la Société de Pathologie Exotique, Bulletin de l'Institut Pasteur, United States Naval Medical Bulletin, Office International d'Hygiene Publique, The Medical Surgeon.

MANAGER'S NOTICES.

The Journal of the Royal Army Medical Corps is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

The Hon. Manager,
"Journal of the Royal Army Medical Corps,"
War Office, Whitehall, S.W.

JOURNAL

OF THE

ROYAL ARMY MEDICAL CORPS.

Corps News.

SEPTEMBER, 1916.

EXTRACT FROM THE "LONDON GAZETTE," TUESDAY, JULY 25, 1916.

Whitehall,
July 22, 1916.

The King has been pleased to give and grant unto the undermentioned officers His Majesty's Royal licence and authority to accept and wear Decorations (as stated against their respective names) which have been conferred upon them by His Highness the Sultan of Egypt, in recognition of valuable services rendered by them :-

THIRD CLASS OF THE ORDER OF THE NILE.

Lieut.-Col. Frederick Fitzgerald Carroll, M.B., Royal Army Medical Corps, Principal Medical Officer, Egyptian Army.

Maj. John Powell, M.B., Royal Army Medical Corps, late Egyptian Army.

EXTRACT FROM FIFTH SUPPLEMENT TO THE "LONDON GAZETTE," TUESDAY, JULY 25, 1916.

War Office,
July 27, 1916.

His Majesty the King has been graciously pleased to approve of the appointment of the undermentioned officers to be Companions of the Distinguished Service Order, in recognition of their gallantry and devotion to duty in the Field :—

Temp. Capt. Walter Dawson, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty when dressing the wounded and directing stretcher-bearers in the firing line. At dusk he searched the Front himself under heavy rifle fire till every wounded man had been removed.

Capt. William Archibald Miller, M.B., Royal Army Medical Corps, Special Reserve (attached 22nd (S) Battalion, Royal Fusiliers).

For conspicuous gallantry and devotion to duty. Captain Miller followed the front line of our attack over ground swept by shell, machine gun and rifle fire. He searched in every direction for wounded, and gained valuable information regarding the situation. This he at once communicated and again continued his search for wounded. This officer has on previous occasions shown distinguished gallantry.

Temp. Lieut. Lionel Matthew Rowlette, Royal Army Medical Corps (attached 1st Battalion, Welsh Guards).

For conspicuous gallantry and devotion to duty. During a heavy bombardment he crawled across the open for a considerable distance to attend to two wounded men. Later he went out again and, although twice wounded, dressed the wounds of seven wounded men and tended them till he had to be himself removed.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers, in recognition of their gallantry and devotion to duty in the field :--

Temp. Capt. Norman Black, M.B., Royal Army Medical Corps (attached 11th Battalion, Argyll and Sutherland Highlanders).

For conspicuous gallantry and devotion to duty. After a shell had blown in his dressing-station and he had been cut, bruised and much shaken, he rested ten minutes and then, although still suffering, went out under heavy fire to attend to a wounded officer in the support trenches.

Temp. Capt. Cyril Mary Brophy, Royal Army Medical Corps (attached 18th Battalion, London Regiment, Territorial Force).

For conspicuous gallantry in leading bearer squads under heavy shell fire. To succour wounded he maintained communication with the regimental aid posts, and so enabled a large number of wounded to be rapidly brought back.

Capt. Harold Francis Lewis Hugo, M.B., Royal Army Medical Corps, Territorial Force, attached Royal 1st Devon Yeomanry).

For conspicuous gallantry, notably when he went to the front line trench under heavy shell fire, and, after his orderly had been dangerously wounded and half buried, stood by and supported him till help arrived. Two officers and two men were killed within a few yards of him. On another occasion he brought in a wounded lieutenant across 200 yards of open ground under sniping fire.

Capt. Arthur Edmund Ironside, 4th London Field Ambulance, Royal Army Medical Corps, Territorial Force.

For conspicuous gallantry and devotion to duty when in charge of bearer subdivisions. He organized the work most efficiently, and assisted in the dressing of wounded under heavy shell fire.

Temp. Capt. Frederic Percy Joscelyne, Royal Army Medical Corps (attached 2nd Battalion, Royal Sussex Regiment).

For consistent gallantry and devotion to duty. He has shown complete disregard of personal danger on all occasions, and has frequently carried out his duties under heavy fire. On one occasion a bullet from a machine-gun passed through his coat, but he showed complete indifference.

Capt. Norman Lockhart Joynt, M.B., Royal Army Medical Corps, Special Reserve (attached 176th Tunnelling Company, Royal Engineers).

For conspicuous gallantry. When the enemy exploded a camouflet which choked a mine gallery with foul gas, he at once organized rescue work, going down himself repeatedly with rescue apparatus. Through his cool bravery he succeeded in personally rescuing two men and ensured the quick recovery of others.

Temp. Capt. John Moir MacKenzie, M.B., Royal Army Medical Corps (attached 6th Battalion, Northumberland Fusiliers, Territorial Force).

For conspicuous gallantry and devotion to duty. Though wounded in the foot and arm he refused to go to hospital, and, four days later, during a heavy hostile bombardment, he went up through the enemy artillery barrage and tended many wounded men, though in considerable pain himself.

Capt. Richard Arthur Stewart, M.B., Royal Army Medical Corps, Special Reserve (attached 2nd Battalion, Border Regiment).

For conspicuous gallantry. During the attack on an enemy position he went forward and established an aid post in a mine crater, and tended many wounded under heavy shell fire. His coolness and disregard of personal safety gave great confidence to those round him.

Temp. Lieut. John Robert Irwin, M.B., Royal Army Medical Corps (attached 2nd Battalion, Worcester Regiment).

For conspicuous gallantry. When the enemy exploded a mine damaging our galleries, he immediately descended into the gallery and at great risk, owing to foul fumes, treated a man and enabled him to be brought up alive.

Temp. Lieut. Charles Cyril Okell, No. 6 Field Ambulance, Royal Army Medical Corps.

For gallant conduct in frequently leading a bearer division over shell swept ground. His bravery and good example greatly assisted in the removal of all our wounded.

Temp. Lieut. Peter Mortimer Turnbull, M.B., Royal Army Medical Corps (attached 2nd Battalion, Royal West Surrey Regiment).

For conspicuous gallantry when tending the wounded under heavy fire on several successive days.

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned man for act of gallantry and devotion to duty in the field :—

1683 Pte. (Acting-Cpl.) H. A. Holt, No. 6 Field Ambulance, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in collecting wounded under very heavy shell fire. His bravery and good work cannot be over-estimated.

EXTRACT FROM THE "LONDON GAZETTE" OF FRIDAY, AUGUST 4, 1916.

War Office,

August 5, 1916.

His Majesty the King has been graciously pleased to award the Victoria Cross to the undermentioned Officer, for most conspicuous bravery and devotion to duty :—

Capt. John Leslie Green, late Royal Army Medical Corps.

For most conspicuous devotion to duty. Although himself wounded, he went to the assistance of an officer who had been wounded and was hung up on the enemy's wire entanglements, and succeeded in dragging him to a shell hole, where he dressed his wounds, notwithstanding that bombs and rifle grenades were thrown at him the whole time.

Captain Green then endeavoured to bring the wounded officer into safe cover, and had nearly succeeded in doing so when he was himself killed.

EXTRACT FROM THE "LONDON GAZETTE" OF TUESDAY, AUGUST 8, 1916, AND THURSDAY, AUGUST 10.

War Office,
August 10, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned Non-commissioned Officers and Men :—

No. 68280 Pte. W. Abberton, Royal Army Medical Corps.
No. 1719 Pte. E. Banks, Royal Army Medical Corps (Territorial Force).
No. 50283 Acting-Cpl. S. Bott, Royal Army Medical Corps.
No. 1823 Pte. A. L. Dean, Royal Army Medical Corps (Territorial Force).
No. 328 Cpl. J. F. Evans, Royal Army Medical Corps (Territorial Force).
No. 4830 Pte. W. W. Harling, Royal Army Medical Corps.
No. 30402 Pte. C. W. Hartrup, Royal Army Medical Corps.
No. 1631 Pte. E. Holness, Royal Army Medical Corps (Territorial Force).
No. 68090 Pte. W. Jarman, Royal Army Medical Corps.
No. 47793 Serjt. W. M. Jones, Royal Army Medical Corps.
No. 669 Cpl. (Acting-Serjt.) T. A. Marlborough, Royal Army Medical Corps.
No. 2157 Serjt. (Acting-Qmr.-Serjt.) C. W. Newell, Royal Army Medical Corps.
No. 50670 Cpl. (Acting-Serjt.) A. J. Pharoah, Royal Army Medical Corps.
No. 485 Staff-Serjt. E. Schofield, Royal Army Medical Corps (Territorial Force).
No. 1614 Pte. P. F. Stevens, Royal Army Medical Corps (Territorial Force).
No. 1884 Pte. W. F. Storey, Royal Army Medical Corps (Territorial Force).
No. 1121 Pte. T. Trainor, Royal Army Medical Corps.
No. 64180 Pte. F. Ward, Royal Army Medical Corps.
No. 68111 Pte. J. W. Whittaker, Royal Army Medical Corps.
No. 1697 Pte. A. L. Youngs, Royal Army Medical Corps (Territorial Force).
No. 65863 Staff-Serjt., F. A. Hodges, Royal Army Medical Corps.
No. 65884 Lance-Cpl. E. T. Fairbrother, Royal Army Medical Corps.
No. 65868 Pte. W. Daniels, Royal Army Medical Corps.

EXTRACT FROM THE "LONDON GAZETTE" OF FRIDAY, AUGUST 18, 1916.

THE GRAND PRIORY OF THE ORDER OF THE HOSPITAL OF ST. JOHN OF JERUSALEM IN ENGLAND.

CHANCERY OF THE ORDER, ST. JOHN'S GATE, CLERKENWELL, LONDON, E.C.
August 15, 1916.

The King has been graciously pleased to sanction the following promotions in, and appointments to, the Order of the Hospital of St. John of Jerusalem in England :—

As Knights of Grace.

Col. Howard Carr, C.B., M.B., Army Medical Service.
Lieut.-Col. Edward Stewart, M.D., M.R.C.P. and S., Royal Army Medical Corps.

India Office,
August 18, 1916.

His Majesty the King has been graciously pleased to approve the undermentioned reward for distinguished service in the field :—

Awarded the Military Cross.

Capt. Gordon Wilson, M.B., Royal Army Medical Corps.

War Office,
August 19, 1916.

His Majesty the King has been graciously pleased to approve of the appointment of the undermentioned officers to be Companions of the Distinguished Service Order, in recognition of their gallantry and devotion to duty in the field.

Temp. Capt. Edward Carwardine Gimson, Royal Army Medical Corps.

For conspicuous gallantry when continually attending to the wounded under very

heavy shell fire. He has displayed the greatest devotion to duty and contempt of personal danger.

Temp. Capt. Penrose Lanyon Watkin-Williams, Royal Army Medical Corps.

For conspicuous gallantry when tending the wounded for six hours in a shell crater under very heavy shell fire. He was twice knocked over by the explosion of shells, and his coat and putties were ripped by shrapnel.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned officers in recognition of their gallantry and devotion to duty in the field:—

Temp. Lieut. George Perry Armstrong, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty when tending the wounded in the open under heavy fire and getting them back to our own lines.

Temp. Lieut. Frank Russell Hassard, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty when collecting the wounded under shell, machine gun and sniper fire.

Temp. Capt. Hubert Arnold Pallant, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty when attending to the wounded under heavy fire. Later, he voluntarily acted as stretcher-bearer and helped to carry off nearly forty wounded under heavy shell and machine-gun fire.

Temp. Lieut. Valentine Frederick Stock. M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. After being rendered unconscious by a shell explosion, he insisted on returning to duty, and for several days carried out his duties by daylight, and exposed to heavy fire.

Temp. Lieut. Gordon Blanchard Wiswell, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty when attending to the wounded and directing stretcher-bearers under shell and machine gun fire without sleep or rest for three days and nights.

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned Non-commissioned Officers for acts of gallantry and devotion to duty in the Field:—

No. 19029 Staff-Serjt. R. E. Harvey, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty when attending to the wounded during a retirement under very trying circumstances. He also saved a man from drowning in the river.

No. 1034 Serjt. W. F. O'Connell, Royal Army Medical Corps.

For conspicuous gallantry in collecting stretcher-bearers under shell fire, leading them across open ground, and establishing communication with Aid Posts. He disregarded all personal danger, and gave a fine example of coolness and courage to all ranks at a critical time.

EXTRACT FROM THE "LONDON GAZETTE" OF TUESDAY, AUGUST 22, 1916.

War Office,
August 23, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned Non-commissioned Officers and Men:—

No. 36763 Acting Lance-Cpl. A. Abel, Royal Army Medical Corps.
No. 30219 Serjt. J. Ashbridge, Royal Army Medical Corps.
No. 38022 Cpl. F. A. Brown, Royal Army Medical Corps.
No. 47878 Pte. G. W. Cooper, Royal Army Medical Corps.
No. 41523 Pte. E. A. Davis, Royal Army Medical Corps.
No. 30952 Serjt. E. J. Doulton, Royal Army Medical Corps.
No. 41542 Pte. C. Gluckstein, Royal Army Medical Corps.
No. 31241 Pte. M. Harris, Royal Army Medical Corps.
No. 49221 Pte. F. J. Haylock, Royal Army Medical Corps.
No. 46290 Serjt. C. A. Hill, Royal Army Medical Corps.
No. 45610 Serjt. J. B. Hyde, Royal Army Medical Corps.
No. 844 Serjt. B. D. Johnstone, Royal Army Medical Corps.
No. 44719 Pte. J. G. Naysmith, Royal Army Medical Corps.
No. 36910 Pte. H. S. Redshaw, Royal Army Medical Corps.
No. 35484 Pte. V. Reynolds, Royal Army Medical Corps.
No. 65632 Cpl. B. A. Seward, Royal Army Medical Corps.
No. 45496 Pte. J. J. Sidders, Royal Army Medical Corps.
No. 42093 Pte. E. J. Trim, Royal Army Medical Corps.
No. 65451 Pte. W. Williams, Royal Army Medical Corps.
No. 53179 Pte. A. T. Woodard, Royal Army Medical Corps.

EXTRACT FROM "THE LONDON GAZETTE" OF FRIDAY, AUGUST 25, 1916.

War Office,
August 25, 1916.

His Majesty the King has been graciously pleased to approve of the appointment of the undermentioned Officers to be Companions of the Distinguished Service Order, in recognition of their gallantry and devotion to duty in the Field :—

Temp.-Lieut. Hugh Llewellyn Glyn Hughes, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He went out in broad daylight, under heavy fire, and bandaged seven wounded men in the open, lying out in an exposed spot for one and a half hours. At nightfall he led a party through a heavy barrage and brought the seven men back.

Temp. Capt. Douglas William Hunter, M.B., Royal Army Medical Corps.

For conspicuous gallantry in action. He tended the wounded incessantly in the open and in the front line trench under very heavy fire. When no combatant officer remained in the battalion he took command, rallied the men and set a splendid example.

Temp. Capt. Henry Harold Robinson, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. After a raid in the enemy's trenches, he twice crawled out in broad daylight to assist wounded men under fire. They were brought in at night.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers in recognition of their gallantry and devotion to duty in the field.

Temp. Capt. Archibald Stirling Kennedy Anderson, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. He was untiring in attending to the wounded, though on more than one occasion his aid post was struck by shells. He went out under heavy shell fire to the assistance of the wounded.

Capt. William Barclay, M.B., Royal Army Medical Corps (Special Reserve).

For conspicuous gallantry and devotion to duty when in charge of a bearer division during operations. He worked often in the open under heavy shell fire, and set a fine example to all under him.

Temp. Lieut. James Roberts Boyd, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty when rescuing, under heavy fire, some men who had been buried in their dug-out. He assisted in the digging out, although temporarily disabled by earth thrown up by a bursting shell, and finally brought in one man alive.

Temp. Capt. Michael Charles Burke, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. He worked incessantly with practically no rest for seven days under shell and machine-gun fire. He greatly encouraged all those round him by his cheeriness and disregard of danger.

Temp. Lieut. Charles Bromley Davies, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. When commanding stretcher-bearers, although wounded himself, he continued his gallant work with practically no rest for six days.

Temp. Capt. James Churchill Dunn, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. He showed an utter disregard of personal danger, and his bravery when tending the wounded was the admiration of all ranks.

Temp. Capt. Ernest Harrison Griffin, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. Without food or sleep he worked incessantly tending the wounded of his own and other units under heavy fire. He showed an absolute disregard of danger. On other occasions he has done similar gallant work.

Capt. Henry Alphonsus Harbison, Royal Army Medical Corps (Special Reserve).

For conspicuous gallantry and devotion to duty in action. When in charge of stretcher-bearers he dug out a man under heavy fire and brought him safely back. He also repeatedly took out parties under heavy fire and evacuated a wood of all wounded.

Capt. William Johnson, M.D., Royal Army Medical Corps (Special Reserve).

For conspicuous gallantry and devotion to duty. He led the bearer division of his unit for seven consecutive days during heavy fighting. He was repeatedly under heavy fire when rescuing the wounded. He has always set a fine example of courage.

Temp. Capt. James Reginald Kemp, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. For several days he was indefatigable in bringing in and tending the wounded, and undoubtedly saved many lives.

Capt. George Herbert Hind Manfield, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. He worked day and night tending the wounded in our advanced positions under heavy fire, and carried many of them down the trench after all his bearers had been wounded.

Temp. Capt. Valentine Cleeve Martyn, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty when tending the wounded under fire. On several occasions he has gone out under circumstances of the greatest danger, but has never hesitated to take any risk in order to reach a wounded man.

Temp. Capt. John Boyd Orr, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. On several occasions he displayed the greatest courage when searching for and tending the wounded.

Temp. Capt. David Pottinger, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. When in charge of stretcher-bearers he showed an utter disregard of danger, and though himself wounded in the face, continued his gallant work during the remainder of the day.

Temp. Capt. Clive Watney Roe, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during three days of hard fighting. He was indefatigable in tending the wounded and displayed great coolness under fire.

Capt. Joseph Wilkie Scott, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. He tended the wounded under heavy fire for several hours, and carried back a number of them to our front line at great personal risk. For some time he took command of and organized the defences of an advanced trench.

Temp. Capt. John Henry Tomlinson, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during a heavy bombardment. He tended the wounded in the main street of a village at great personal risk till he was severely wounded by a fragment of a shell.

ARMY MEDICAL SERVICE.

Col. Charles E. Nichol, C.M.G., D.S.O., M.B., to be temporary Surg.-Gen. whilst a Director of Medical Services, dated June 28, 1916.

The following Lieut.-Cols. to be temporary Colonels whilst Assistant Directors of Medical Services of Divisions:—

Gerard W. Tate, M.B., dated August 4. 1916; Francis E. Gunter, M.B., dated August 4, 1916.

Col. M. T. Yarr, C.B., to be temporary Surg.-Gen. whilst a D.M.S. (without the pay or allowances of that rank), dated August 3, 1916.

Col. William H. Horrocks, M.B., K.H.S., is retained on the Active List, under the provisions of Arts. 120 and 522, Royal Warrant for Pay and Promotion, and to be supernumerary, August 25, 1916.

The undermentioned Lieut.-Cols. to be temporary Colonels whilst Assistant Directors of Medical Services of a Division:—

Michael Boyle, M.B., dated January 24, 1916.
Ernest W. Bliss, dated June 22, 1916.
John Grech, D.S.O., dated July 3, 1916.

ROYAL ARMY MEDICAL CORPS.

Major Ibar, A. O. MacCarthy is retained on the Active List under the provisions of Arts. 120 and 522, Royal Warrant for Pay and Promotion, and to be supernumerary, dated July 28, 1916.

Capt. Robert W. D. Leslie is granted the local rank of Major whilst employed on embarkation duties, August 25, 1916.

QUEEN ALEXANDRA'S IMPERIAL MILITARY NURSING SERVICE.

Matron Miss Louisa M. Stewart, R.R.C., is retained supernumerary to establishment, August 11, 1916.

Sister Miss Hannah Suart, R.R.C., to be Matron, August 11, 1916.

ROYAL ARMY MEDICAL CORPS CENTRAL MESS FUND.

THE Annual General Meeting was held in the Library of the Royal Army Medical College on Monday, June 19, 1916.

Surg.-Gen. Sir Alfred Keogh, K.C.B., Director-General A.M.S., in the Chair.

The Minutes of the last Annual General Meeting were read and confirmed.

The Accounts for the years ended February 28, 1915, and February 29, 1916, having been, after audit, submitted by the Committee were unanimously adopted. [They will be found in the issues of the Corps Journal for April and June, 1916].

The Hon. Secretary reported that the principal event since the last meeting had been the generous gift of their cash balance (£138) and various articles of plate by the members of the late Mess at Roberts' Heights, which had been closed shortly after the outbreak of War. It will be remembered that similar action was taken by the members of the Tempe Mess and that those of Quetta had the same intention. The Messes at Bangalore and Lucknow which were in danger of closure had been helped by the Central Fund; as had the Peshawar Mess. The heavy loss of the London Mess on the maintenance account had been partly met by the Fund. Details will be found in the proceedings of the Committee recorded in the March, 1916, issue of the Journal. There was a considerable credit balance, which, as far as possible, was invested in Exchequer Bonds; but the Hon. Secretary was informed by more than one Mess Secretary that there would be heavy calls on the Fund at the end of the War.

Mr. E. T. Gann was appointed auditor for the current year.

3, *Homefield Road,*
Wimbledon.

J. T. CLAPHAM, *Captain,*
Hon. Secretary.

MARRIAGE.

HARVEY—ROTHERA.—On August 18, at the Parish Church, Beeston, Notts, Major G. A. D. Harvey, R.A.M.C., to Gwendel, only daughter of Frank Rothera, Esq., M.D., and Mrs. Rothera, Old Manor House, Beeston, Notts.

DEATH.

HARDING.—Died of cholera on August 10, at Bombay, while in command of No. 22 Stationary Hospital, Major N. E. Harding, R.A.M.C., aged 41, elder son of the late J. H. Harding, of Redonda, W.I., and dearly beloved husband of Dorothy Harding. *Pro Rege et Patria.*

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, and Proceedings of the United Services Medical Society.

Any demand for excerpts, additional to the above, or for reprints, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates :—

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	16	0 10 6	0 5 0				
50	4	0 4 6	0 1 10				
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	16	0 13 3	0 5 10				
100	4	0 6 0	0 3 1				
	8	0 10 0	0 4 10	7 10	3 11	6 7	2 5
	16	0 18 6	0 7 6				
200	4	0 9 6	0 4 5				
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G. STREET & CO., Ltd., 8, Serle Street, London, W.C.

The back outside cover is not available for advertisements.

The above figures are subject to 15 per cent. increase.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

All such Communications or Articles accepted and published in the "Journal of the Royal Army Medical Corps" will (unless the Author notifies at the time of submission that he reserves the copyright of the Article to himself) become the property of the Library and Journal Committee, who will exercise full copyright powers concerning such Articles.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," War Office, Whitehall, London, S.W.

Communications have been received from G. Perret, Esq., M.D., J. Walker Hall, Esq., M.D., B. A. I. Peters, M.D., F. Nicholls, Esq.; Colonels H. N. Thompson, C.M.G., Andrew Fullerton, C.M.G., A. H. Tubby, C.M.G., Cuthbert S. Wallace, C.M.G., R. H. Firth; Lieutenant-Colonels P. Sargent, G. Holmes, C. S. Myers, C. J. Martin, G. A. Wright, Sir John Collie, M. H. Gordon, O. W. A. Elsner; Majors J. F. Brown, T. J. Cream, V.C., D.S.O., W. G. D. Upjohn, T. R. Elliott, T. W. A. Daman, T. G. M. Hine, G. Stoker, E. T. Burke, A. F. Hertz; Captains A. Rocke Robertson, J. B. Fisher, M. Donaldson, E. Alment, A. J. Wright, G. H. Hunt, J. W. McNee, J. E. H. Roberts, R. S. S. Statham, C. G. L. Wolf, W. B. Davy, E. T. Bourke, B. C. Maybury, B. H. Barton, A. Lundie, H. Henry, H. G. Gibson, M. Flack, K. B. MacGlasham, R. L. Scott, J. Inkster, T. J. Mackie, H. G. Wiltshire, D. J. Scott; Lieutenants R. L. Thornley, W. C. Ball; Quartermaster J. Watson.

The following publications have been received:—

British: Journal of the Royal Naval Medical Service, The Medical Journal of South Africa, The Hospital, The Lancet, Tropical Diseases Bulletin, The Medical Journal of Australia, The Medical Press and Circular, Proceedings of the Royal Society of Medicine, St. Bartholomew's Hospital Report, 1915, *Guy's Hospital Gazette, The Practitioner, The Indian Medical Gazette, The Quarterly Journal of Medicine, The Royal Engineers' Journal, Journal of the United Service Institution of India, Red Cross and Ambulance News, The Journal of Tropical Medicine and Hygiene, Yellow Fever Commission (West Africa), The Medical Review, Public Health, The Journal of State Medicine, The Third Report of the Indigenous Drugs Committee, The Parliament of the Commonwealth of Australia, The Army Service Corps Journal.*

Foreign: Bulletin de l'Institut Pasteur, l'Ospedale Maggiore, Bulletin of the Johns Hopkins Hospital, Giornale di Medicina Militare, Tidskrift i Militär Hälsovard, Revista de Sanidad Militar, Archives de Médicine et de Pharmacie Militaires, Bulletin de la Société de Pathologie Exotique, The Military Surgeon, Office International d'Hygiene Publique, Arquivos do Instituto Bacteriologico Camara Peslana, Le Caducée, United States Public Health Service, Annali di Medicinia Navale E Coloniale.

MANAGER'S NOTICES.

The JOURNAL OF THE ROYAL ARMY MEDICAL CORPS is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

THE HON. MANAGER,
"JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."
WAR OFFICE, WHITEHALL, S.W.

JOURNAL
OF THE
ROYAL ARMY MEDICAL CORPS.

Corps News.

October, 1916.

LIST No. 189.

General Headquarters,
August 31, 1916.

Under authority granted by His Majesty the King to the Commander in Chief, the following honours have been awarded to the undermentioned for devotion to duty on the field, for the operations described in General Sir John Maxwell's dispatch of March 1, 1916:—

DISTINGUISHED CONDUCT MEDAL.

Royal Army Medical Corps.

No. 8994 Serjt.-Major Charles Kingston.
No. 43124 Staff-Serjt. Alexander Brown Grindlay.
No. 41916 Pte. Wilfred Chalkley.

(Signed) S. H. POLLEN, *Lieut.-Col.*,
Assistant Military Secretary, E.E.F.

EXTRACTS FROM THE "LONDON GAZETTE."

War Office,
September 1, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned non-commissioned officers and men:—

No. 66595 Pte. H. H. Adlem, Royal Army Medical Corps.
No. 44417 Acting-Cpl. G. Asbury, Royal Army Medical Corps.
No. 47771 Pte. C. Barton, Royal Army Medical Corps.
No. 41614 Pte. W. E. Bond, Royal Army Medical Corps.
No. 30227 Serjt. H. H. Bradshaw, Royal Army Medical Corps.
No. 75636 Pte. (Acting Lance-Cpl.) J. W. Bramhill, Royal Army Medical Corps.
No. 128 Pte. R. Brown, Royal Army Medical Corps.
No. 1828 Cpl. C. H. F. Clinton, Royal Army Medical Corps.
No. 72264 Serjt. G. W. Cook, Royal Army Medical Corps.
No. 66620 Pte. H. G. Cook, Royal Army Medical Corps.
No. 279 Pte. E. Dibbo, Royal Army Medical Corps.
No. 332 Pte. W. Doughty, Special Reserve, Royal Army Medical Corps.
No. 845 Serjt. P. Earl, Royal Army Medical Corps.
No. 123 Lance-Cpl. G. H. Fisher, Royal Army Medical Corps.

No. 39917 Pte. W. Hopson, Royal Army Medical Corps.
No. 82331 Pte. H. Inskipp, Royal Army Medical Corps.
No. 72 Pte. A. Linley, Royal Army Medical Corps.
No. 1569 Pte. J. MacDonald, Royal Army Medical Corps.
No. 1603 Pte. E. Middleton, Royal Army Medical Corps.
No. 173 Pte. E. Northend, Royal Army Medical Corps.
No. 34 Cpl. A. Poulson, Royal Army Medical Corps.
No. 66475 Pte. A. H. Poulter, Royal Army Medical Corps.
No. 1832 Cpl. C. E. Raflin, Royal Army Medical Corps.
No. 1670 Serjt. F. W. Robson, Royal Army Medical Corps.
No. 12440 Serjt. R. Smith, Royal Army Medical Corps.
No. 2271 Pte. H. C. Staton, Royal Army Medical Corps.
No. 20516 Pte. A. V. Stevens, Royal Army Medical Corps.
No. 364 Pte. M. W. Todd, Royal Army Medical Corps.
No. 57008 Pte. G. A. Waterman, Royal Army Medical Corps.
No. 5941 Pte. A. Watson, Royal Army Medical Corps.

War Office,
September 14, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned:—

No. 1738 Lance-Cpl. J. Abrahams, Royal Army Medical Corps.
No. 7533 Pte. W. H. Andrews, Royal Army Medical Corps.
No. 53100 Acting Lance Serjt. C. F. Ashbee, Royal Army Medical Corps.
No. 4088 Pte. (Acting-Cpl.) C. H. Banyard, Royal Army Medical Corps.
No. 281 Qmr.-Serjt. J. W. Barker, Royal Army Medical Corps.
No. 1740 Pte. F. Barlow, Royal Army Medical Corps.
No. 36794 Cpl. C. F. Berry, Royal Army Medical Corps.
No. 7433 Pte. H. T. Berryman, Royal Army Medical Corps.
No. 1722 Pte. A. Bradshaw, Royal Army Medical Corps.
No. 53149 Pte. S. A. Brown, Royal Army Medical Corps.
No. 19595 Staff-Serjt. C. E. Bull, Royal Army Medical Corps.
No. 76340 Pte. E. Burnley, Royal Army Medical Corps.
No. 2236 Pte. W. Bushell, Royal Army Medical Corps.
No. 1772 Cpl. M. A. Butler, Royal Army Medical Corps.
No. 1798 Acting Lance-Cpl. R Capell, Royal Army Medical Corps.
No. 282 Serjt. W. G. Carroll, Royal Army Medical Corps.
No. 7345 Cpl. (Acting-Serjt.) Collins, Royal Army Medical Corps.
No. 14810 Serjt. W. H. Colville, Royal Army Medical Corps.
No. 57841 Serjt. C. J. H. Davies, Royal Army Medical Corps.
No. 46241 Pte. H. Deer, Royal Army Medical Corps.
No. 812 Cpl. J. Dick, Royal Army Medical Corps.
No. 74191 Pte. C. E. Dive, Royal Army Medical Corps.
No. 43224 Pte. H. Downs, Royal Army Medical Corps.
No. 1791 Serjt. P. G. Elsey, Royal Army Medical Corps.
No. 1787 Pte. E. G. Finney, Royal Army Medical Corps.
No. 1373 Pte. (Acting-Cpl.) W. J. Franklin, Royal Army Medical Corps.
No. 46887 Pte. (Acting-Serjt.) A. Freeman, Royal Army Medical Corps.
No. 32016 Pte. J. W. Fry, Royal Army Medical Corps.
No. 13200 Pte. (Acting Lance-Cpl.) W. Gentle, Royal Army Medical Corps.
No. 266 Staff-Serjt. W. E. George, Royal Army Medical Corps.
No. 55591 Pte. T. Gray, Royal Army Medical Corps.
No. 10831 Serjt. H. W. Gregory, Royal Army Medical Corps.
No. 954 Serjt. H. C. Hallet, Royal Army Medical Corps.
No. 17379 Serjt. E. Hardy, Royal Army Medical Corps.
No. 17319 Staff-Serjt. A. T. Hort, Royal Army Medical Corps.
No. 17084 Staff-Serjt. J. Hunter, Royal Army Medical Corps.
No. 12483 Pte. (Acting-Serjt.) A. E. Itter, Royal Army Medical Corps.
No. 13178 Cpl. (Acting-Serjt.) A. Jolley, Royal Army Medical Corps.
No. 47974 Serjt. (now Serjt.-Major) D. Jones, Royal Army Medical Corps.
No. 34153 Pte. H. E. Keane, Royal Army Medical Corps.
No. 19710 Serjt. H. S. King, Royal Army Medical Corps.
No. 47320 Cpl. (Acting-Serjt.) Kingsnorth, Royal Army Medical Corps.

No. 58003 Serjt. (now Serjt.-Major) A. E. Kitchen, Royal Army Medical Corps.
No. 35142 Serjt. J. H. Langton, Royal Army Medical Corps.
No. 33148 Qmr.-Serjt. H. W. Lee, Royal Army Medical Corps.
No. 32943 Cpl. (Acting-Serjt.) A. H. C. Lerpiniere, Royal Army Medical Corps.
No. 35903 Serjt. W. T. Lindsay, Royal Army Medical Corps.
No. 20340 Pte. J. Ludlow, Royal Army Medical Corps.
No. 18323 Pte. F. B. Luke, Royal Army Medical Corps.
No. 16903 Staff-Serjt. A. Male, Royal Army Medical Corps.
No. 3234 Pte. P. McCann, Royal Army Medical Corps.
No. 58752 Pte. J. McTurk, Royal Army Medical Corps.
No. 57957 Serjt. C. Minns, Royal Army Medical Corps.
No. 6293 Pte. W. Morgan, Royal Army Medical Corps.
No. 19472 Serjt. C. E. Munson, Royal Army Medical Corps.
No. 45466 Pte. (Acting Lance-Cpl.) F. H. Odell, Royal Army Medical Corps.
No. 12362 Serjt. T. Porter, Royal Army Medical Corps.
No. 46657 Pte. W. Powell, Royal Army Medical Corps.
No. 1160 Pte. C. A. Sasse, Royal Army Medical Corps.
No. 30297 Cpl. T. H. Shaw, Royal Army Medical Corps.
No. 3401 Pte. (Acting-Serjt.) J. Sherman, Royal Army Medical Corps.
No. 1136 Cpl. F. C. Smith, Royal Army Medical Corps.
No. 1858 Pte. L. A. Stork, Royal Army Medical Corps.
No. 7977 Pte. T. Summerson, Royal Army Medical Corps.
No. 1427 Pte. J. E. Thompson, Royal Army Medical Corps.
No. 47443 Pte. R. Thorogood, Royal Army Medical Corps.
No. 15967 Serjt. W. T. Tringham, Royal Army Medical Corps.
No. 1847 Pte (Acting-Serjt.) G. Waller, Royal Army Medical Corps.
No. 31745 Serjt. J. H. Walter, Royal Army Medical Corps.
No. 34273 Serjt. G. P. Welch, Royal Army Medical Corps.
No. 12302 Staff-Serjt. W. Whyte, Royal Army Medical Corps.

War Office,
September 21, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned Non-commissioned Officers and men:—

No. 40908 Pte. J. Andress, Royal Army Medical Corps.
No. 40917 Pte. J. E. Barr, Royal Army Medical Corps.
No. 7753 Pte. A. Black, Royal Army Medical Corps.
No. 35739 Pte. E. C. Brown, Royal Army Medical Corps.
No. 54626 Serjt. A. T. Burton, Royal Army Medical Corps.
No. 39719 Pte. J. Fielding, Royal Army Medical Corps.
No. 987 Serjt. R. Fraser, Royal Army Medical Corps.
No. 32225 Pte. E. L. Holmes, Royal Army Medical Corps.
No. 804 Serjt. R. Jennings, Royal Army Medical Corps.
No. 1581 Pte. P. V. Jones, Royal Army Medical Corps.
No. 36384 Serjt. W. Jones, Royal Army Medical Corps.
No. 31812 Cpl. J. Mackie, Royal Army Medical Corps.
No. 2586 Pte. (Acting-Cpl.) J. McElhatton, Royal Army Medical Corps.
No. 26318 Pte. H. E. Moorcock, Royal Army Medical Corps.
No. 1114 Serjt. F. Rogers, Royal Army Medical Corps.
No. 1722 Pte. W. Scorgie, Royal Army Medical Corps.
No. 58999 Serjt. H. A. Shoebridge, Royal Army Medical Corps.
No. 1638 Pte. (Acting-Serjt.) J. Smith, Royal Army Medical Corps.
No. 33588 Staff-Serjt. R. B. Vincent, Royal Army Medical Corps.
No. 32509 Acting-Cpl. R. G. Wardrop, Royal Army Medical Corps.
No. 45 Pte. (Lance-Cpl.) H. Wiles, Royal Army Medical Corps.
No. 40270 Cpl. (Acting-Serjt.) J. Wilkinson, Royal Army Medical Corps.
No. 1386 Cpl. A. E. Wilson, Royal Army Medical Corps.

War Office,
September 22, 1916.

His Majesty the King has been graciously pleased to approve of the appointments of the undermentioned officers to be Companions of the Distinguished Service Order, in recognition of their gallantry and devotion to duty in the field:—

Temp. Capt. Lancelot Gerard Bourdillon, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. When an officer had been killed carrying in a wounded serjeant, Captain Bourdillon went out in broad daylight, bandaged the serjeant's wounds, and only came in when certain that the latter could not live.

Capt. William Kealty Campbell, M.B., Royal Army Medical Corps, Special Reserve.
For conspicuous gallantry and devotion to duty. He went ahead of the bearers and dressed the wounded in the open under heavy shell fire. Whilst establishing advanced dressing stations he was wounded and half-blinded by the explosion of a shell, but carried on his work. He set a splendid example to those around him.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers in recognition of their gallantry and devotion to duty in the field:—

Temp. Lieut. John Vincent Bates, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty when tending wounded men under heavy shell fire, utterly regardless of his own safety. He made repeated efforts to save wounded men from burning when his dressing station was set on fire by a shell. His conduct throughout several days of heavy fighting was very fine.

Temp. Capt. Cyril Armand Bernard, Royal Army Medical Corps.
For great gallantry and devotion to duty in volunteering to conduct, under very heavy shell fire, stretcher-bearers bringing in wounded. He made several trips and brought in many wounded.

Temp. Capt. Arthur Joseph Blake, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. He tended wounded men incessantly day and night under most trying conditions. He went out into "No Man's Land" searching for any wounded men who might still be lying there.

Temp. Capt. John Maitland Forsyth, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. When the battalion was subjected to continuous heavy shell fire, he tended the wounded with great courage. On hearing that an officer was badly wounded out in the front, he went out at once under heavy fire to look for him. He has always carried out his duties under fire with the greatest coolness and courage.

Temp. Capt. Francis Joseph Henry, Royal Army Medical Corps.
For conspicuous gallantry and devotion during operations. Captain Henry attended the wounded night and day unceasingly in the regimental Aid Post, which was in an exposed position and damaged by shell fire. He also went into the open under heavy artillery and machine-gun fire.

Temp. Lieut. James Arthur Liley, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty when tending the wounded in the open and in the front trenches under very heavy shell fire. His coolness under heavy fire had a great moral effect on the men.

Capt. George Reginald Edward Gray Mackay, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He went across the open to tend the wounded in a trench which was being heavily shelled, and helped them into safety. On the same day he went out again to help some stretcher-bearers and wounded under heavy fire. He saved many lives and set a final example of courage.

Temp. Capt. Dugald Black MacLean, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. He worked incessantly, attending the wounded in the open, with practically no rest for three days, under heavy shell and machine-gun fire. His keenness and bravery inspired the stretcher-bearers.

Temp. Capt. George MacLeod, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during several days of operations. He worked unceasingly tending and bringing in wounded officers and men, frequently in the open and under heavy fire. He set a splendid example to those round him.

Capt. Campbell McNeill McCormack, M.B., Royal Army Medical Corps, Special Reserve.
For conspicuous gallantry and devotion to duty during operations. He directed the stretcher-bearers under heavy shell fire with the greatest coolness and courage. He succeeded in entering a village which had been heavily shelled, and, with another Captain, a serjeant and four men, collected the wounded into a dug-out and succeeded in getting them back later. He has frequently shown great courage.

Temp. Capt. Samuel Wilson McLellan, M.D., F.R.C.S., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty in action. He brought up stretcher-bearers during the attack, and, though soon wounded and rendered unconscious by a shell, he resumed work immediately on his recovery, and carried on under very heavy shell fire. He worked without stopping for thirty hours.

Temp. Lieut. Frank Percival Montgomery, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. He collected and evacuated large numbers of wounded under heavy shell and machine-gun fire, working for five days in the open practically without sleep. He set a splendid example.

Temp. Capt. Duncan Westlake Pailthorpe, Royal Army Medical Corps.
For conspicuous gallantry and devotion during operations, when attending the wounded in the open near the firing line under heavy fire of all descriptions, utterly regardless of personal danger.

Temp. Capt. Murray Hulme Paterson, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. He went out twice by daylight into "No Man's Land" and brought in wounded men. When his battalion was relieved, he remained in his Aid Post till it was cleared of wounded. He did fine work.

Temp. Capt. Arthur Owen Playford Reynolds, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion during operations, when tending the wounded under heavy fire for thirty-six consecutive hours. He also made two gallant attempts to bring in a wounded officer under very heavy fire.

Capt. Archibald Watson Russell, M.B., Royal Army Medical Corps, Special Reserve.
For conspicuous gallantry and devotion during protracted operations. He voluntarily remained days and nights in the trenches and in the open dressing the wounded under heavy fire. He carried in several wounded men, and on one occasion he was partially buried.

Capt. Noel Humphrey Wykeham Saw, Royal Army Medical Corps, Special Reserve.
For conspicuous gallantry and devotion to duty. He worked incessantly for five days and nights tending the wounded brought in from "No Man's Land." He went out himself to direct operations connected with collecting the wounded quite regardless of the heavy fire.

Capt. George Macdonald Scott, Royal Army Medical Corps, Special Reserve.
For conspicuous gallantry and devotion to duty in tending the wounded in "No Man's Land" under heavy artillery and machine-gun fire. Finally he carried in a wounded officer on his back, but collapsed from his efforts. When he recovered he insisted on returning at once to duty, and continued dressing the wounded between the lines till he was knocked over by a shell and incapacitated.

Temp. Capt. Wilfrid Archer Sneath, M.B., F.R.C.S., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. He was out every night tending the wounded under fire. On one occasion he went out 200 yards in advance of our front line and dressed a wounded man under machine-gun fire, afterwards bringing him in.

Temp. Capt. James Smith Stewart, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. When the advanced dressing-station was heavily shelled he worked continuously tending the wounded, and went up and down the road for the same purpose. He personally assisted in rescuing seven buried men under heavy fire.

Temp. Capt. Allen Edgar Thompson, M.D., Royal Army Medical Corps.
For conspicuous gallantry and skill during operations when attending wounded under heavy fire for thirty-six consecutive hours. Many times he searched ruined trenches and open ground for wounded, and, although struck several times by shell splinters, and once buried by shell explosion, he continued his gallant work.

Lieut. James Ernest Studholme Wilson, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. He went up to the front line from his aid post through a very heavy barrage, in order to assist the wounded. By his pluck and skill he undoubtedly saved many lives. He afterwards controlled the evacuation of the casualties under heavy fire.

Capt. William Louis Rene Wood, Royal Army Medical Corps.
For consistent gallantry and devotion to duty. On one occasion he went under very heavy shell fire to attend to the wounded, and also assisted to dig others out. By his coolness and example he has rendered great assistance under the most trying and dangerous conditions.

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned Non-commissioned Officers and Men for acts of gallantry and devotion to duty in the field:—

31540 Serjt. H. Bagenal, Royal Army Medical Corps.
For conspicuous gallantry during operations. He was in charge of the stretcher-bearers, and carried out his work with the greatest coolness and bravery under intense shell fire. On one occasion he carried an urgent message at great personal risk to a medical officer of another battalion.

27773 Pte. H. Calvert, Royal Army Medical Corps.
For conspicuous gallantry while acting as one of the advanced stretcher-bearers. He repeatedly made journeys across the open under intense shell fire to bring in wounded men, and exhibited the greatest courage in the performance of his hazardous duties.

36386 Pte. (Actg. Cpl.) R. Jenkins, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty on several occasions when acting as one of the advanced stretcher-bearers. He repeatedly made journeys, under intense shell fire, to bring in wounded men. He invariably showed willingness and courage, and set a splendid example to all with him.

2064 S./S. N. Laird, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty when in charge of stretcher-bearers during operations. Owing to his fine example, all the wounded were collected in spite of shell and machine gun fire.

1916 Cpl. S. Page, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He rendered first-aid to the wounded close behind the firing line with great zeal, and organized their dispatch to the dressing-station.

2324 Serjt. W. P. Powell, Royal Army Medical Corps.
For conspicuous gallantry in charge of bearers, frequently close up to the enemy's wire, and in the open, under heavy artillery fire. On two occasions enemy patrols were encountered, who fired on his party, but he continued, with great coolness and courage, to carry on his work.

9862 S./S. W. F. Raven, Royal Army Medical Corps.
For conspicuous good work and devotion to duty. He displayed great energy in providing shelters and organizing a dressing-station for the wounded, and showed untiring zeal in tending them.

31150 S./S. G. Simons, Royal Army Medical Corps.

For conspicuous and continuous gallantry with a bearer party. On one occasion he was struck on the face by shrapnel and twice was buried by shells, but he persisted in carrying on his work, frequently under very heavy fire, regardless of all personal danger.

The undermentioned have been awarded a Bar to their Distinguished Conduct Medals for subsequent acts of conspicuous bravery:—

* * * * *

54003 Cpl. S. McKenna, Royal Army Medical Corps.

For conspicuous gallantry and devotion in attending to and carrying in under heavy fire large numbers of wounded, who had been lying in the open. He repeatedly led stretcher-parties to the front line, and refused rest and food while he knew wounded were lying about.

(The Distinguished Conduct Medal was awarded in *London Gazette*, dated April 15, 1916, p. 3991.)

War Office,
London, S.W.
September 25, 1916.

The following dispatches have been received by the Secretary of State for War from the Commander-in-Chief, Egyptian Expeditionary Force:—

General Headquarters,
July 1, 1916.

Sir,—In accordance with the closing paragraph of my dispatch of June 1, 1916, I have the honour to submit a list of the names of those Officers, Non-commissioned Officers and men whose services I consider deserving of special mention, and I beg to recommend them to your notice.

I will, at a later date, submit to you a further list of names of Officers, Non-commissioned Officers and men, belonging to the Salonika Army, whom I desire to mention in dispatches, and recommend for reward.

I have the honour to be,
Your most obedient servant,
A. J. Murray, *General.*
Commander-in-Chief, Egyptian Expeditionary Force.

Keble, Lieut.-Col. (temp. Col.) A.E.C., D.S.O., Royal Army Medical Corps.
McIntosh, Major (temp. Lieut.-Col.) A.M., M.B., Royal Army Medical Corps (Territorial Force).

Royal Army Medical Service and Royal Army Medical Corps.

O'Sullivan, Col. D., F.R.C.S.I.
Wilson, Capt. M. O., M.B., Royal Army Medical Corps.
Makgill, Temp. Capt. R. H., M.D. (since relinquished his commission).
Satow, Temp. Capt. L. L.

Royal Army Medical Corps (Territorial Force).

Buchanan, Capt. (temp. Major), T. G., M.B., North Midland Mounted Brigade Field Ambulance.
Proudfoot, Capt. R., M.D., Welsh Divisional Sanitary Section.
Tuke, Capt. A. L. S., M.B., attached Fife and Forfar Yeomanry.
Humphreys, Capt. H. F., M.B., 2nd South Midland Mounted Brigade Field Ambulance.
Eastes, Capt. G. L., 2nd London Sanitary Company.
Bromet, Capt. E., attached East Riding Yeomanry.
Davies, No. 3070 Serjt. A. H., 2nd London Sanitary Company.
Austin, No. 703 Pte. P., 2nd South Midland Mounted Brigade Army Service Corps (late 2nd South Midland Mounted Brigade Field Ambulance).

General Headquarters.
July 13. 1916.

SIR, -In accordance with the closing paragraph of my dispatch of June 1, 1916, and with reference to the last paragraph of my letter, dated July 1, 1916, I have the honour to forward herewith a further list of the names of Officers, Non-commissioned Officers and men, belonging to the Salonika Army, whom I desire to mention in dispatches and recommend for reward.

I have the honour to be,
Your most obedient servant,
A. J. MURRAY, *General.*
Commander-in-Chief, Egyptian Expeditionary Force.

Sutton, Col. A. A., D.S.O., A.M.S.
Holt, Col. M. P. C., C.B., D.S.O., A.M.S.

ROYAL ARMY MEDICAL CORPS.

Birrell, Lieut.-Col. E. T. F., C.M.G., M.B.
Rudkin, Capt. G. F.
Davis, Temp. Capt. H. H., F.R.C.S.

ROYAL ARMY MEDICAL CORPS (TERRITORIAL FORCE).

English, Capt. (temp. Lieut.-Col. Royal Army Medical Corps), T. C., M.B., F.R.C.S. 4th London General Hospital.

APPOINTMENTS, COMMISSIONS, REWARDS, ETC.

Approved by the Commander-in-Chief. Egyptian Expeditionary Force (subject to War Office approval where authority is not quoted.)

LIST No. 192.

General Headquarters,
September 7, 1916.

HONOURS AND REWARDS.

His Majesty the King of Serbia has, with the approval of His Majesty the King, bestowed the following Decorations on the undermentioned officers and men, of the Mediterranean Expeditionary Force, or who have served or are now serving in Egypt or at Salonika, in recognition of their distinguished service during the Campaign.

There are no restrictions as to the occasions on which any of these Decorations may be worn.

White Eagle 3rd Class.

Lieut.-Col. (temp. Col.), Alfred Ernest Conquer Keble, D.S.O., Royal Army Medical Corps.

White Eagle 5th Class.

Capt. Robert Proudfoot, Welsh Divisional Sanitary Section, Royal Army Medical Corps (Territorial Force).

Temp. Capt. Henry Wade, M.B., Royal Army Medical Corps (Territorial Force), attached Scottish Horse Mounted Brigade Field Ambulance.

Capt. James Gerald Fayrer Hosken, Royal Army Medical Corps (Territorial Force).

Cross of Karageorge (with Swords) 1st Class.

No. 150, Pte. Alexander McInnes, 2nd Lowland Field Ambulance (Territorial Force).

Silver Star, 2nd Class.

No. 2226, Pte. Hugh Jones, 2/2nd Welsh Field Ambulance (Territorial Force).

Gold Medal.

No. 1555, Pte. Moses Martin, 1/1st Lowland Field Ambulance (Territorial Force).

No. 170, Pte. Herbert James Bolwell, 1st East Lancashire Field Ambulance (Territorial Force).

Silver Medal.

No. 1607, Pte. Albert William Francis, 8th Mounted Brigade Field Ambulance (1/4th London) (Territorial Force).

ARMY MEDICAL SERVICE.

Col. James C. Morgan is placed temporarily on the Half-pay List on account of ill-health, September 29, 1916.

Lieut.-Col. E. M. Pilcher, D.S.O., M.B., F.R.C.S., R.A.M.C., to be Brevet-Col., September 12, 1916.

Lieut.-Col. Arthur Kennedy, from Royal Army Medical Corps, to be Colonel, *vice* Col. J. C. Morgan, September 29, 1916.

ROYAL ARMY MEDICAL CORPS.

Lieut.-Col. Alfred T. I. Lilly is retained on the Active List under the provisions of Arts. 120 and 522 R. Warrant for Pay and Promotion, and to be supernumerary, September 8, 1916.

Lieut.-Col. James S. Green, M.B., retires on retired pay on account of ill-health, September 26, 1916.

Capt. R. J. B. Buchanan, from retired pay, is reinstated in the Royal Army Medical Corps, and to be Temp. Capt. whilst commanding a Prisoners of War Camp. July 10, 1916. (Substituted for the notification in the *Gazette* of July 22, 1916.)

Major Edgar E. Powell, from Supernumerary List, to be Lieut.-Col., September 29, 1916.

Capt. Ronald E. Todd, M.B., is reinstated to establishment, August 15, 1916.

STATEMENT OF ACCOUNTS FROM JULY 1, 1915, TO JUNE 30, 1916.

BALANCE SHEET.

Liabilities.	£ s. d.	Assets.	£ s. d.	£ s. d.
To Publishers' Bill for June Quarter, 1916	356 13 3	By Cash at Bank		282 9 8
,, Balance Credit	2,509 5 7	,, Value Stamps in Hand		1 16 11
		,, Investments :—		
		India Stock at (minimum price)	£807 10 0	
		Tasmanian Stock (at minimum price)	188 0 0	
		War Loan Bonds cum rights purchased October 27, 1915 (at cost)	1,477 3 8	
				2,472 13 8
		,, Furniture, etc., as per last Balance Sheet	19 7 3	
		Written off for depreciation ..	1 18 8	
				17 8 7
		,, Outstanding for Subscriptions		8 0 0
		,, Do. Advertisements		88 10 0
	£2,865 18 10			£2,865 18 10

TRADING ACCOUNT.

From July 1, 1915, to June 30, 1916.

Expenditure.

	£ s. d.	£ s. d.
To Publishers' Bills—		
Journal		1,260 18 10
Corps News		142 17 2
Extra Cost of Paper		23 3 7
Reprints		17 19 1
Envelopes, Postage and Packing		52 9 4
Sundries		1 5 9
,, Purchase of War Loan Bonds (£1,500) ex Rights, with Consols as shown in Balance Sheet for 1914-15	£975 0 0	
To which was added Cash to the Amount of	493 3 6	
		1468 3 6
,, Balance to Profit and Loss Account..		206 13 11
		£3,173 11 2

Receipts.

	£ s. d.	£ s. d.	£ s. d.
By Subscriptions to Journal		1,230 5 2	
,, ,, Outstanding June 30, 1916		8 0 0	
		1,238 5 2	
Deduct Subscriptions credited in error ..	£1 0 0		
Deduct Subscriptions outstanding June 30, 1915	53 0 0		
		54 0 0	
			1,184 5 2
By Subscriptions to Corps News			12 5 4
,, Receipts for Reprints			6 16 9
,, Advertisements			275 11 3
,, Sales through Manager			4 13 2
,, ,, ,, Publishers			220 2 6
,, Sale of War Loan Bonds ex Rights..			1,469 17 0
			£3,173 11 2

PROFIT AND LOSS ACCOUNT.

From July 1, 1915, to June 30, 1916.

Expenditure.

	£ s. d.	£ s. d.
To Business Manager's Account—		
Clerk to Manager	24 0 0	
,, Editor	12 12 0	
Postages	17 2 10	
Stationery..	0 11 6	
Postman	1 0 0	
Addressograph	0 5 5	
		55 11 9
,, Honorarium to Editor..		100 0 0
,, ,, Assistant Editor		37 10 0
,, ,, Auditor		2 2 0
,, Exchange on Drafts		0 2 0
,, Cheque Book		0 4 2
,, Written off for Depreciation of Furniture ..		1 18 8
,, Balance carried to Balance Sheet—		
Balance, July 1, 1915	2,393 1 2	
Net Profit during the year* ..	116 4 5	
		2,509 5 7
		£2,706 14 2

Receipts.

	£ s. d.
By Balance from last Account	2,393 1 2
,, Gross Profit on Trading Account	206 13 11
,, Interest on India Stock	29 14 11
,, ,, Consols	16 8 2
,, ,, Tasmanian Stock	6 16 0
,, ,, War Loan Bonds	54 0 0
	£2,706 14 2

* Against this amount is a claim from the Publishers for £95 8s. 6d. being a charge of 15 per cent. more on Journal orders placed with them from February to June, 1916, inclusive, owing to increased cost of production. The claim is still under consideration by the Library and Journal Committee.

(Signed) A. WEBB, *Lieut.-Colonel, R.A.M.C.*
Hon. Manager, Journal R.A.M.C.

Examined and found correct,
(Signed) EDMOND T. GANN.

August 25, 1916.

ACKNOWLEDGMENT FROM OFFICER COMMANDING R.A.M.C RECORDS.

The Officer-in-Charge R.A.M.C. Records acknowledges receipt of £36 0s. 2d., proceeds of a concert given at Kirkee, India, on Tuesday, July 11, 1916, by the members of the late 16th Stationary Hospital, in aid of the widows and families of those members who died whilst on active service with the unit.

The Officer-in-Charge R.A.M.C. Records has, therefore, remitted £12 to the widow of No. 31656 Serjt. B. T. Colls, £12 to the widow of No. 58831 Pte. H. Bate, and £12 to the mother of No. 60386 Pte. J. F. Owen, and has forwarded their grateful acknowledgements to the Officer Commanding the late 16th Stationary Hospital.

BIRTH

O'FLAHERTY.—On September 10, at 10, Loveday Road, Ealing, W., the wife of Lieut.-Col. A. R. O'Flaherty, R.A.M.C., of a son.

MARRIAGE.

ALLNUTT—GAINSFORD.—On July 27, 1916, at Hitchin, Herts, Captain E. B. Allnutt, M.C., R.A.M.C., to Joan Cicely, daughter of the Rev. G. B. Gainsford, M.A., and Mrs. Gainsford, of Woodside, Hitchin, Herts.

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, and Proceedings of the United Services Medical Society.

Any demand for excerpts, additional to the above, or for reprints, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates :—

Number of Reprints	Number of Pages	Cost of Reprints	Cost of Excerpts *	Extra for Covers for Reprints: As Journal, Printed on Front	Extra for Covers for Reprints: As Journal, Plain, Unprinted	Extra for Covers for Reprints: Cheaper Paper, Printed on Front	Extra for Covers for Reprints: Cheaper Paper, Plain, Unprinted
		£ s. d.	£ s. d.	s. d.	s. d.	s. d.	s. d.
12	4	0 2 9	0 1 2				
	8	0 5 0	0 2 3	4 3	1 1	3 10	0 9
	16	0 8 3	0 3 11				
25	4	0 3 4	0 1 5				
	8	0 6 0	0 2 9	4 10	1 6	4 4	0 11
	16	0 10 6	0 5 0				
50	4	0 4 6	0 1 10				
	8	0 7 6	0 3 6	5 0	2 1	4 10	1 2
	16	0 13 3	0 5 10				
100	4	0 6 0	0 3 1				
	8	0 10 0	0 4 10	7 10	3 11	6 7	2 5
	16	0 18 6	0 7 6				
200	4	0 9 6	0 4 5				
	8	0 15 0	0 6 7	10 10	7 6	9 0	4 10
	16	1 6 0	0 9 8				

* These are not arranged as Reprints, but appear precisely as in the Journal with any other matter that may happen to appear on the first and last pages of the particular excerpt ordered.

Cases for Binding Volumes.—Strong and useful cases for binding can be obtained from the publishers at the undermentioned rates:—

Covers, 1s. 8d. net; binding, 1s. 6d.

These charges are exclusive of cost of postage.

In forwarding parts for binding the name and address of sender should be enclosed in parcel.

All Applications for Advertisements to be made to—

G. STREET & CO., Ltd., 8, Serle Street, London, W.C.

The back outside cover is not available for advertisements.

The above figures are subject to 15 per cent. increase.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

All such Communications or Articles accepted and published in the "Journal of the Royal Army Medical Corps" will (unless the Author notifies at the time of submission that he reserves the copyright of the Article to himself) become the property of the Library and Journal Committee, who will exercise full copyright powers concerning such Articles.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," War Office, Whitehall, London, S.W.

Communications have been received from Colonel Andrew Fullerton; Lieut.-Col. H. E. Winter; Majors A. Maitland Ramsay, G. Stoker; Captains A. Howard Pirie, C. F. Strange, G. Vilvandre, H. I. Pechell, J. B. Grogan, J. M. Anderson, W. Jameson, A. Sandison.

The following publications have been received:—

British: The Medical Journal of South Africa, The Hospital, The Practitioner, Transactions of the Society of Tropical Medicine and Hygiene, Guy's Hospital Gazette, Journal of the Royal United Service Institution, The Lancet, The Royal Engineers' Journal, Journal of the Royal Sanitary Institute, The Journal of State Medicine, The Medical Journal of Australia, The Indian Medical Gazette, The Medical Review, The Medical Press and Circular, Red Cross and Ambulance News, Indian Journal of Medical Research, The R.A.M.C. Depot Magazine, Public Health, Tropical Diseases Bulletin, The British Journal of Surgery, The British Journal of Tuberculosis, The Journal of Tropical Medicine and Hygiene.

Foreign: United States Public Health Service, Memorias do Instituto Oswaldo Cruz, l'Ospedale Maggiore, Revista de la Sanidad Militar, Bulletin de l'Institut Pasteur, Militaerlaegen, The Military Surgeon, United States Department of Agriculture, Bulletin of the Johns Hopkins Hospital, Archives de Médecine et de Pharmacie Militaires, Le Caducée, The Journal of Infectious Diseases, Norsk Tidsskrift for Militaermedicin.

MANAGER'S NOTICES.

The Journal of the Royal Army Medical Corps is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

The Hon. Manager,
"Journal of the Royal Army Medical Corps,"
War Office, Whitehall, S.W.

JOURNAL

OF THE

ROYAL ARMY MEDICAL CORPS.

Corps News.

November, 1916.

EXTRACTS FROM THE "LONDON GAZETTE."

September 26, 1916.

His Majesty the King has been graciously pleased to approve of the appointments of the undermentioned Officers to be Companions of the Distinguished Service Order, in recognition of their gallantry and devotion to duty in the field :—

Temp. Capt. Norman Walford Broughton, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. During a very heavy bombardment he, on three occasions, helped to dig out men from blown-in dug-outs. Shells were bursting all round him, but he refused to take cover, and it was mainly due to his efforts that most of the buried men were rescued. He has done other fine and gallant work.

Temp. Capt. Douglas William Hunter, M.B., Royal Army Medical Corps.

For exceptional gallantry and devotion to duty. This officer laboured incessantly tending and clearing the wounded in the open and in front line trenches under very heavy fire. At a critical time when casualties had been heavy he steadied and reorganized his stretcher-bearers by his magnificent example and skilful control. After the battalion had withdrawn he continued searching the battle field for wounded. He showed absolute disregard of danger.

(Substituted for the announcement published in the *London Gazette* dated August 25, 1916).

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers in recognition of their gallantry and devotion to duty in the field :—

Capt. William Barnsley Allen, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He was telephoned for when an artilleryman was severely wounded, and came in at once over ground which was being heavily shelled at the time. On another occasion he did similar fine work under heavy shell fire.

Temp. Capt. George Galen Bartholomew, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. His dressing station was continually under shell fire, but he tended the wounded with the greatest coolness and courage. He remained in the line thirty hours after the battalion had been removed. He had previously done similar fine work.

Temp. Capt. Frank Dallimore, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. Under heavy shell and machine-gun fire, after his aid post had been blown in, he continued dressing the wounded, and only retired after every man had been attended to, and safely removed. Twice previously he had done similar fine work.

Temp. Capt. Norman Clotworthy Graham, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. For several days he was constantly tending the wounded under heavy shell fire. He refused to leave the lines when the battalion had been relieved until he had attended to all the wounded of many other units. During the whole time he had hardly an hour's rest.

Temp. Lieut. Paul McDonald Little, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He collected and tended the wounded under very heavy fire during three days and nights. He also went out under heavy shell fire and brought in two wounded stretcher-bearers, and was going out again for two more when a shell fell and killed them both.

Temp. Capt. John McIntosh Morgan, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. He has shown an utter disregard of personal danger on several occasions when tending and removing the wounded.

Temp. Capt. Burford Noel Norman, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He worked for practically forty-eight hours attending the wounded. His post was often shelled, but he only ceased work when he was physically incapable of further effort.

Capt. Frederic Sanders, M.B., Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty in action. For forty-eight consecutive hours he worked in "No Man's Land," tending and carrying in the wounded, although he himself wounded at the time.

Temp. Capt. John Maitland Stenhouse, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during several days of operation, when attending to the wounded under heavy shell fire. He repeatedly exposed himself when dressing wounds, and finally was himself wounded.

Capt. Pensam Thornton, Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty during operations. He did fine work among the wounded under fire, and, though badly wounded in two places, stuck to his work, though repeatedly urged to have his wounds properly dressed. He refused to leave the trenches until every wounded man had been brought in.

Capt. Guy Torrance, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He moved about under heavy fire and rendered first aid to about 180 officers and men. When his dressing-station was blown in by a shell and his serjeant mortally wounded he continued his work in the open.

Capt. William Semple Wallace, M.B., Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty in action. Under very heavy shell fire he tended and directed the removal of the wounded. He continued working after being twice buried and partly stunned by exploding shells.

Temp. Capt. Charles McMoran Wilson, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He worked for over an hour digging out wounded men, at great personal risk. He then returned to his aid post and attended to the wounded. Later, hearing that an officer had been wounded, he passed through 100 yards of the enemy's artillery barrage, dressed his wounds, and finally got him into safety as soon as the barrage permitted. On other occasions he has done fine and gallant work.

Capt. Joseph Wilkie Scott, M.D., Royal Army Medical Corps.

For conspicuous gallantry in going forward with his stretcher-bearers and when all his party, with the exception of one non-commissioned officer, had become casualties, he reached our advanced trench. In a shallow broken trench he tended wounded for several hours. He carried back wounded at great personal risk, and for some time organised the removal of wounded from the advanced trench.

(Substituted for the announcement published in the *London Gazette*, dated August 25, 1916).

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned Warrant Officer, Non-commissioned Officers and Men for acts of gallantry and devotion to duty in the field:—

No. 41916 Pte. W. Chalkley, Royal Army Medical Corps.

For conspicuous and consistent good work and devotion to duty.

No. 43124 Staff-Serjt. A. B. Grindley, Royal Army Medical Corps.

For conspicuous good work and devotion to duty.

No. 39928 Serjt. G. Jacobs, Royal Army Medical Corps.

For conspicuous gallantry during operations. When his stretcher-bearers were dazed by the intense shell fire he jumped on the parapet, and with the assistance of an orderly carried the first case through the barrage. The other bearers at once followed his lead.

No. 8994 Serjt.-Major C. Kingston, Royal Army Medical Corps.

For conspicuous and consistent good work. He has shown marked ability and initiative in times of emergency.

No. 7154 Pte. (Acting Cpl.) T. Simmonds, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. Although knocked down by a falling beam in the evacuation dug-out which had been hit by a shell, he calmly dressed a serjeant who had been wounded. He then started off up the road under heavy shell fire, to warn the medical officer not to send up any more cases, as the stretcher-bearers would probably be killed. On his way he extricated a wounded bearer, who was buried, and got him into safety.

No. 40233 Lance-Cpl. F. Turner, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He went out under heavy shell fire and tended the wounded. When all his stretcher squad had become casualties, he brought in single-handed four wounded men under very heavy shell fire, and continued to work afterwards for thirty-five hours with the greatest bravery and coolness, although wounded by shrapnel.

War Office,
October 11, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned:—

No. 33642 Pte. A. Binks, Royal Army Medical Corps.
No. 8650 Pte. W. Casewell, Royal Army Medical Corps.
No. 6451 Serjt. G. A. Cocks, Royal Army Medical Corps.
No. 49838 Pte. P. Condron, Royal Army Medical Corps.
No. 38627 Pte. F. Dando, Royal Army Medical Corps.
No. 6331 Pte. W. E. H. Fairfield, Royal Army Medical Corps.
No. 51540 Cpl. J. H. Freeman, Royal Army Medical Corps.
No. 31672 Staff-Serjt. W. Furminger, Royal Army Medical Corps.
No. 33048 Serjt. G. W. Furniss, Royal Army Medical Corps.
No. 538 Staff-Serjt. C. H. Gibb, Royal Army Medical Corps.
No. 49592 Pte. J. H. Hawkes, Royal Army Medical Corps.
No. 12618 Staff-Serjt. W. A. Mayman, Royal Army Medical Corps.
No. 6600 Pte. P. G. K. McLeod, Royal Army Medical Corps.
No. 3795 Cpl. J. Morrison, Royal Army Medical Corps.
No. 37048 Serjt. L. L. Page, Royal Army Medical Corps.
No. 19748 Cpl. (Acting Serjt.) C. H. Parr, Royal Army Medical Corps.
No. 49500 Pte. H. Rush, Royal Army Medical Corps.
No. 49520 Staff-Serjt. F. Setters, Royal Army Medical Corps.
No. 2791 Acting-Cpl. J. Sykes, Royal Army Medical Corps.

War Office,
October 18, 1916.

His Majesty the King has been graciously pleased to award the Meritorious Service Medal to the undermentioned Non-Commissioned Officers and men, in recognition of valuable services rendered during the present War:—

No. 2398 Staff-Serjt A. W. Allison, Royal Army Medical Corps.
No. *53100 Acting-Serjt. C. F. Ashbee, Royal Army Medical Corps.
No. *7433 Pte. H. T. Berryman, Royal Army Medical Corps.
No. *19595 Staff-Serjt. C. E. Bull, Royal Army Medical Corps.
No. 2108 Cpl. T. B. Claydon, Royal Army Medical Corps.
No. *11810 Serjt. W. H. Colville, Royal Army Medical Corps.
No. 19021 Qmr.-Serjt. (Acting-Serjt.-Major) A. A. Dell, Royal Army Medical Corps.
No. *812 Cpl. J. Dick, Royal Army Medical Corps.
No. 1618 Serjt. F. A. Dolling, Royal Army Medical Corps.
No. *1791 Serjt. P. G. Elsey, Royal Army Medical Corps.
No. 42844 Serjt. T. B. Fairfull, Royal Army Medical Corps.
No. 64 Pte. E. Fellows, Royal Army Medical Corps.
No. *1373 Pte. (Acting-Cpl.) W. J. Franklin, Royal Army Medical Corps.
No. *32016 Pte. J. W. Fry, Royal Army Medical Corps.

No. *266 Staff-Serjt. W. E. George, Royal Army Medical Corps.
No. *10831 Serjt. H. W. G. Gregory, Royal Army Medical Corps.
No. 44572 Staff-Serjt. R. G. Griggs, Royal Army Medical Corps.
No. 736 Staff-Serjt. W. K. Hadingham, Royal Army Medical Corps.
No. 954 Serjt. H. C. Hallet, Royal Army Medical Corps.
No. 79 Serjt. F. H. Hankins, Royal Army Medical Corps.
No. 57653 Pte. R. F. Hanslar, Royal Army Medical Corps.
No. *17379 Serjt. E. Hardy, Royal Army Medical Corps.
No. *17084 Staff-Serjt. J. Hunter, Royal Army Medical Corps.
No. 12483 Pte. (Acting-Serjt.) A. E. Itter, Royal Army Medical Corps.
No. 11822 Serjt. G. E. Johnson, Royal Army Medical Corps.
No. 724 Pte. P. Kilburn, Royal Army Medical Corps.
No. *33148 Qmr.-Serjt. H. W. Lee, Royal Army Medical Corps.
No. *35903 Serjt. W. T. Lindsay, Royal Army Medical Corps.
No. 1718 Pte. (Acting-Cpl.) L. W. Lowe, Royal Army Medical Corps.
No. *18903 Staff-Serjt A. Male, Royal Army Medical Corps.
No. 2745 Pte. (Acting-Cpl.) C. Martin, Royal Army Medical Corps.
No. *19472 Serjt. C. E. Munson, Royal Army Medical Corps.
No. 18940 Qmr.-Serjt. (Acting Serjt.-Major) P. H. Musgrave, Royal Army Medical Corps.
No. 31080 Staff-Serjt. J. K. Niven, Royal Army Medical Corps.
No. *12362 Serjt. T. Porter, Royal Army Medical Corps.
No. 1383 Cpl. J. Rouse, Royal Army Medical Corps.
No. *30297 Cpl. T. H. Shaw, Royal Army Medical Corps.
No. *3401 Pte. (Acting-Serjt.) J. Sherman, Royal Army Medical Corps.
No. *7977 Pte. T. Summerson, Royal Army Medical Corps.
No. *15967 Serjt. W. T. Tringham, Royal Army Medical Corps.
No. *12302 Staff-Serjt. W. Whyte, Royal Army Medical Corps.
No. 232 Staff-Serjt. T. Wood, Royal Army Medical Corps.
No. 2162 Pte. J. E. Woodward, Royal Army Medical Corps.

Note.—The names marked with an asterisk were published in error in the *Gazette* of September 14, 1916, in the list of Military Medal Awards, and that announcement in respect of these Non-commissioned Officers and men is accordingly cancelled.

War Office,
October 19, 1916.

The following despatch from Lieut-Gen. Sir Percy Lake, K.C.B., has been forwarded by the Government of India for publication :—

General Headquarters,
Indian Expeditionary Force "D,"
Basrah, *August* 24, 1916.

From the General Officer Commanding Indian Expeditionary Force "D." To the Chief of the General Staff, Army Headquarters, India.

Sir,—With reference to my despatch dated August 12, 1916, paragraph 78, I have the honour to submit a detailed list of Officers, Warrant Officers, Non-commissioned Officers and men whom I desire to bring to special notice.

I have the honour to be, Sir,
Your most obedient servant,
P. Lake, *Lieut.-General,*
Commanding Indian Expeditionary Force "D."

Tate, Col. A. E., A.M.S.

War Office,
October 19, 1916.

The Government of India has received from Lieut.-Gen. Sir Percy Lake the following list of names of officers and others recommended by Major-Gen. Townshend for distingushed service during the defence of Kut-al-Amarah :—

Browne-Mason, Lieut.-Col., H.O.B., Royal Army Medical Corps.

MEDICAL SERVICE.

Aylen, Major E. V., Royal Army Medical Corps.
Cane, Capt. A. S., Royal Army Medical Corps.
Cane, Capt. E. G. S., Royal Army Medical Corps.
Hennessy, Lieut.-Col. J., C.B., M.B., Royal Army Medical Corps.
Lambert, Major F. C., Royal Army Medical Corps (deceased).

War Office,
October 19, 1916.

His Majesty the King has been graciously pleased to approve of the undermentioned Honours and Rewards for distinguished service in the field, with effect from June 3, 1916, inclusive:—

TO BE COMPANIONS OF THE DISTINGUISHED SERVICE ORDER.

Major Ernest Vaughan Aylen, M.B., Royal Army Medical Corps.
Lieut.-Col. Hubert Oliver Browne Browne-Mason, Royal Army Medical Corps.
Capt. Leo Murphy, Royal Army Medical Corps.

AWARDED THE MILITARY CROSS.

Capt. Albert Thomas James McCreery, M.B., Royal Army Medical Corps.

War Office,
October 20, 1916.

His Majesty the King has been graciously pleased to approve of the appointments of the undermentioned officers to be Companions of the Distinguished Service Order, in recognition of their gallantry and devotion to duty in the field:—

Surg.-Major Francis William Bailey, Royal Field Artillery (Medical Officer).

For conspicuous gallantry and devotion to duty. When the batteries of his brigade came under heavy shell fire, he at once went out to tend the wounded and dying in the open with utter disregard of danger.

Major Michael Joseph Mahoney, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. When his aid post was blown in he at once established another under heavy shell-fire, and tended the wounded for two days and nights. When relieved he took a few hours rest and then returned to his gallant work.

Capt. Joseph Ellis Milne, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He has repeatedly tended the wounded under heavy shell-fire, and has shown himself utterly regardless of personal safety.

Capt. Edgar Percival, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He led a party of stretcher-bearers into a wood, and remained for over two hours searching for wounded under shell and machine-gun fire. On previous occasions he has done similar gallant work.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers and Warrant Officers in recognition of their gallantry and devotion to duty in the field:—

Temp. Capt. Harold Ackroyd, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He attended the wounded under heavy fire, and finally, when he had seen that all our wounded from behind the line had been got in, he went out beyond the front line and brought in both our own and enemy wounded, although continually sniped at.

Temp. Lieut. Frederick Alexander Anderson, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. When his aid post was hit and all his assistants were wounded, he himself being badly bruised, he helped to dig out three buried men under heavy shell fire. He stuck to his duty till his battalion was relieved.

Temp. Lieut. Bernard Francis Bailey, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. For two days and nights he tended the wounded under heavy shell-fire. He was stunned by a shell, but, on regaining consciousness half an hour later, continued his fine work with the greatest coolness.

Temp. Capt. Cyril Carlyle Beatty, Royal Army Medical Corps.

For conspicuous courage and coolness when in charge of an advanced dressing-station. By his fine work he has ensured quick and successful evacuation of wounded from the aid posts. In times of difficulty he set an invaluable example.

Temp. Lieut. James Gordon Bell, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded under heavy shell-fire. On being relieved he heard that some wounded men had been left in a trench and immediately went back two and a-half miles with stretcher party through heavy shelling and brought in three wounded men.

Temp. Capt. Thomas Bourne-Price, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He went from place to place under very heavy shell-fire to try and get into communication with the ambulance cars. Finally, he was half smothered by the explosion of three successive heavy shells. For many months he has done very fine and gallant work when in charge of stretcher-bearers, and when tending and evacuating wounded under shell-fire.

Capt. William Bowater, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He collected the wounded from the front line trenches and advanced dressing-stations under heavy shell-fire during several days. He allowed himself hardly any rest, and set a fine example to his men.

Capt. Samuel Brown, Royal Army Medical Corps.

For conspicuous devotion to duty during operations. He was blown up by a shell, and was so much injured that he had to spend the night in a field ambulance; but, though still suffering, he returned to duty next day. A few days later he was again blown up. He had never spared himself, and has displayed the greatest gallantry.

Temp. Capt. William Campbell, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He repeatedly attended the wounded under heavy shell fire. On one occasion, when a dug-out had been hit by a gas shell, he went in to attempt the rescue of those within under very dangerous conditions.

Temp. Lieut. John Russell Christian, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. When Brigade Headquarters was shelled by the enemy, one man being mortally wounded and two officers incapacitated, he remained with them all night exposed to shell fire. After the wounded had been removed to safety, he remained behind in order that other units might know where to find him. He has done other fine work.

Temp. Capt. Arthur Gruchy Clark, M.B., Royal Army Medical Corps.

For conspicuous gallantry and good work, controlling bearers at the Front under very heavy fire. He did especially good work in advanced trenches.

Temp. Lieut. Vincent Middleton Coates, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. During an attack he tended the wounded under very difficult circumstances, working without assistance after his orderly was hit. He was under heavy shell fire.

Capt. Aston Ridley Dale, Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty during operations He was untiring in his efforts on behalf of the wounded, and showed great courage when a shell burst in the entrance of his dressing station, killing his orderly and wounding a serjeant.

Temp. Capt. Douglas Allan Donald, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. When a dug-out was hit by a gas-shell, he twice entered and removed two wounded men under very dangerous conditions. He had previously been working continuously for forty-eight hours removing the wounded from aid-posts.

Temp. Lieut. Richard Felton, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He tended the wounded during an intense bombardment, and, a few days later, when a shell blew in the orderly room, killing three men and burying the remainder, he rescued the latter under most dangerous conditions. But for his pluck and devotion to duty many more lives would have been lost.

Temp. Capt. William Eric Giblin, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. He tended the wounded in "No Man's Land" under heavy shell and machine gun fire, and showed an utter contempt of danger.

Capt. Samuel Sowray Greaves, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. For thirty-six hours he tended the wounded in the open. On several other occasions he has shown great courage under heavy shell fire.

Temp. Capt. John Greene, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He tended the wounded under heavy shell fire, though himself injured by a shell which burst only ten yards from him. He immediately returned to duty after being tended at the dressing station.

Capt. Eben Stuart Burt Hamilton, M.B., Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty during operations. He rescued three severely wounded men from the ruins of a dug-out under heavy shell fire. As he was removing the last man the dug-out was blown in on him, and he had himself to be dug out. He has done other fine work and has shown an utter disregard of danger.

Temp. Capt. John Bowman Hunter, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He tended the wounded under heavy shell fire when the battalion had suffered heavy casualties. By his fine example he inspired all under him with courage and energy.

Temp. Capt. Ernest Emrys Isaacs, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He tended the wounded in a very exposed position for twelve hours, some of them being wounded and one actually killed by shell fire in his aid-post. At one time he had worked unceasingly for thirty-five hours without food, drink or rest, having divided up his food and water among those of the wounded who most needed it.

Capt. Frank Graham Lescher, Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and initiative in searching for wounded under heavy shell fire. He repeatedly led his bearers through heavy barrage. He continued his work until he had got all the wounded to safety.

Temp. Capt. Kenneth William Mackenzie, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. His aid-post was continually shelled, but he carried on with great determination. He, personally, assisted some of the walking cases across the shelled area, and, when water ran out, went himself across the open to get some. He showed an utter disregard of personal safety.

Temp. Lieut. George Boyd McTavish, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. Throughout very severe fighting he was responsible, by his energy, courage, and contempt for danger, in saving a large number of severely wounded who had been left in the battered front line trenches or in "No Man's Land."

Temp. Lieut. Gregor Mackenzie Miller, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. By his splendid example and cheerfulness he gave great encouragement to the men under heavy and continuous shell-fire. He volunteered to remain in the front line trenches, where he saved the lives of many badly wounded men by being on the spot.

Temp. Capt. Francis John Morris, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He led his stretcher-bearers to collect wounded in full view of the enemy's position, and set a fine example to all near him. He has done other similar gallant work.

Temp. Capt. Bartholomew Joseph Mullin, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He tended the wounded under heavy shell-fire after himself being knocked down by a shell. He had to work in an open trench without any overhead cover, and exposed to enfilade fire.

Capt. Hugh Roger Partridge, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during protracted operations. During several weeks he was in charge of a collecting post and repeatedly under heavy shell-fire. He has shown the greatest coolness, and has worked incessantly evacuating the wounded. He has been hit more than once by debris, and has set a fine example to those around him.

Temp. Capt. Wellington Le Roy Pedlow, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He tended the wounded utterly regardless of the enemy's fire, and carried a severely wounded officer from a very exposed part of the captured position to the aid-post, being fired at all the way.

Capt. Rudolph Albert Peters, M.B., Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty during operations. He tended the wounded the whole day and night under heavy shell fire, and at night was instrumental in getting in many wounded, who were lying out in front in the open.

Temp. Capt. Nicol McNicoll Rankin, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in remaining at his post and attending to wounded after the regimental aid post had received three direct hits and he himself had been wounded in the face. For four hours he continued at duty, the area around his aid post being heavily shelled all the time.

Temp. Capt. Charles Roche, Royal Army Medical Corps.
For conspicuous courage and skill in the performance of his duties, many times under fire. He organized large stretcher parties and rescued many seriously wounded men from points which were constantly under heavy fire. He has displayed great devotion to duty under distressing circumstances.
Capt. Hugh Kingsley Ward, M.B., Royal Army Medical Corps, Special Reserve.
For conspicuous gallantry and devotion to duty during operations. He has shown an utter contempt for danger, going to any and every place, however exposed, in which there were wounded men. He has himself been wounded by a shell while carrying out this gallant work.

SOUTH AFRICAN CONTINGENT.

Capt. Albert Groenwald, M.D., Medical Officer (attached South African H.).
For conspicuous gallantry and devotion to duty during several actions. He tended the wounded under fire with utter disregard to his personal safety.
Capt. Stephen Liebson, South African Medical Corps.
For conspicuous gallantry and devotion to duty when tending the wounded during operations. Though himself wounded and with nothing but a small trench to work in, he carried on during several days under heavy shell and sniping fire with the greatest courage.
The undermentioned Officer has been awarded a Bar to his Military Cross for subsequent acts of conspicuous gallantry:—
Temp. Capt. William Howard Lister, M.C., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. For thirty hours he supervised the work of his stretcher-bearers in the open under heavy shell fire. On another occasion he searched a wood for wounded under very heavy shell fire.
(The Military Cross was awarded in *London Gazette* dated June 23, 1915.)

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned Non-commissioned Officers and men for acts of gallantry and devotion to duty in the field:—
No. 45510 Acting Serjt. H. W. Abbiss, Royal Army Medical Corps.
For conspicuous bravery and devotion, during lengthy operations, in leading and directing his stretcher squads in the open and under very heavy shell fire. On one occasion, when all his men were away carrying the wounded, he continued to dress and attend wounded during an intense bombardment of an hour and a half, one man being killed while he was in the act of dressing him.
No. 37443 Serjt. J. Ellis, Royal Army Medical Corps.
For conspicuous bravery and devotion when leading and directing stretcher-bearers, under a heavy fire, for thirty-six hours. On one occasion he volunteered to go forward and administer first-aid in the open, under very heavy shell-fire, before the stretcher parties could advance.
No. 987 Serjt. R. Fraser, Royal Army Medical Corps.
For conspicuous gallantry during operations. When it was reported that stretcher-bearers were in difficulty up the road, he immediately went out and, though knocked over and practically buried by a shell, brought in the party to a dressing station. He has done other fine and gallant work.
No. 13059 Cpl. J. B. Purvis, Royal Army Medical Corps.
For conspicuous gallantry on many occasions since the commencement of the campaign, and notably when for five days he remained in the open, without relief, directing stretcher-bearers and continually exposed to shell fire.
No. 58909 Pte. A. Samson, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. On one occasion when most of his comrades had become casualties he continued to assist the wounded to the dressing station with the greatest coolness and courage.
No. 37645 Serjt. T. Smalley, Royal Army Medical Corps.
For conspicuous bravery and devotion during operations, when he collected wounded and rendered first-aid in the open under heavy shell fire, although he was himself wounded early in the action.
No. 15803 Serjt. H. B. Stuart, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. He went forward by himself under very heavy shell fire to offer assistance and see if stretcher-bearers were required. On another occasion, when several casualties occurred in the trench, he was the first to go to their assistance under very heavy shell fire. His plucky example gave great encouragement to the troops holding the trench.

War Office,
October 21, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the Field to the undermentioned Non-commissioned Officers and Men:—

No. 45115 Pte. S. Benson, Royal Army Medical Corps.
No. 20712 Pte. T. H. Bridge Royal Army Medical Corps.
No. 53148 Pte. E. Broomhall, Royal Army Medical Corps.
No. 5210 Pte. S. Burke, Royal Army Medical Corps.
No. 56710 Pte. J. Burton, Royal Army Medical Corps.
No. 6398 Serjt. R. H. Coad, Royal Army Medical Corps.
No. 73998 Pte. J. Cockburn, Royal Army Medical Corps.
No. 20124 Pte. W. S. Cox, Royal Army Medical Corps.
No. 2295 Pte. L. Crecraft, Royal Army Medical Corps.
No. 2404 Pte. A. E. Davey, Royal Army Medical Corps.
No. 40189 Pte. P. O. Davies, Royal Army Medical Corps.
No. 37701 Cpl. G. B. Dickinson, Royal Army Medical Corps.
No. 30210 Serjt. W. Eldridge, Royal Army Medical Corps.
No. 1430 Pte. W. Elliott, Royal Army Medical Corps.
No. 68148 Pte. H. H. Evans, Royal Army Medical Corps.
No. 58780 Pte. J. Fitzsimmons, Royal Army Medical Corps.
No. 64548 Pte. M. Gallewski, Royal Army Medical Corps.
No. 967 Cpl. T. E Garland, Royal Army Medical Corps.
No. 49581 Pte. J. Golden, Royal Army Medical Corps.
No. 30578 Acting Serjt., M. Griffiths, Royal Army Medical Corps.
No. 37916 Pte. G. W. Harrison, Royal Army Medical Corps.
No. 41546 Pte. (Acting-Serjt.) P. Higginson, Royal Army Medical Corps.
No. 27344 Pte. W. Hodson, Royal Army Medical Corps.
No. 49287 Cpl. D. J. Jones, Royal Army Medical Corps.
No. 39442 Pte. J. Lindsay, Royal Army Medical Corps.
No. 45633 Pte. L. A. Lindsey, Royal Army Medical Corps.
No. 38770 Serjt. J. McCall, Royal Army Medical Corps.
No. 16102 Pte. N. McDonnell, Royal Army Medical Corps.
No. 62196 Pte. M. Moore, Royal Army Medical Corps.
No. 50553 Pte. R. Musker, Royal Army Medical Corps.
No. 8403 Pte. T. Page, Royal Army Medical Corps.
No. 47171 Pte. A. Perrin, Royal Army Medical Corps.
No. 41576 Pte. T. S. Pugh, Royal Army Medical Corps.
No. 6824 Pte. A. C. J. Robbins, Royal Army Medical Corps.
No. 68771 Pte. (Lance-Cpl.) T. Robinson, Royal Army Medical Corps.
No. 5664 Cpl. J. Rogers, Royal Army Medical Corps.
No. 1082 Pte. W. Rose, Royal Army Medical Corps.
No. 66356 Pte. F. G. Scribbins, Royal Army Medical Corps.
No. 27757 Pte. A. Simpson, Royal Army Medical Corps.
No. 56547 Pte. T. Standen, Royal Army Medical Corps.
No. 63916 Pte. J. Todd. Royal Army Medical Corps.
No. 12781 Cpl. W. Walton, Royal Army Medical Corps.
No. 123 Pte. W. D. Warwick, Royal Army Medical Corps.
No. 64651 Pte. J. Willis, Royal Army Medical Corps.
No. 39188 Pte. G. Wood, Royal Army Medical Corps.

The undermentioned have been awarded a Bar to their Military Medal:—

No. 58725 Pte. J. McTurk, Royal Army Medical Corps.

(The award of the Military Medal was published in the *London Gazette*, dated September 14, 1916.)

War Office,
October 25, 1916.

The following Dispatch has been received by the Secretary of State for War from General Sir Reginald Wingate, G.C.B., Sirdar and Governor-General of the Sudan.

Khartoum,
August 8, 1916.

Medical Corps.

Capt. R. C. Archibald, M.B., Royal Army Medical Corps.
Capt. C. Cassidy, M.B., Royal Army Medical Corps.
Capt. A. G. Cummins, M.B., Royal Army Medical Corps.
No. 1430 Serjt. W. T. Perkins, Royal Army Medical Corps.

Capt. D. S. Buist, M.B., Royal Army Medical Corps.
Capt. E. Gibbon, M.B., Royal Army Medical Corps.
Major R. G. Anderson, Royal Army Medical Corps.
Major W. Byam, Royal Army Medical Corps.
Lieut.-Col. F. F. Carroll, M.B., Royal Army Medical Corps.
No. 12504 Qmr.-Serjt. E. Shepherd, Royal Army Medical Corps.
No. 11896, Qmr.-Serjt. A. P. Spackman, Royal Army Medical Corps.
No. 10504, Pte. T. R. Begley, Royal Army Medical Corps.

War Office,
October 26, 1916.

His Majesty the King has been graciously pleased to award the Victoria Cross to the undermentioned officers:—

Capt. William Barnsley Allen, M.C., M.B., Royal Army Medical Corps.

For most conspicuous bravery and devotion to duty.

When gun detachments were unloading H.E. ammunition from wagons which had just come up, the enemy suddenly began to shell the battery position. The first shell fell on one of the limbers, exploded the ammunition and caused several casualties.

Capt. Allen saw the occurrence and at once, with utter disregard of danger, ran straight across the open, under heavy shell fire, commenced dressing the wounded, and undoubtedly by his promptness saved many of them from bleeding to death.

He was himself hit four times during the first hour by pieces of shells, one of which fractured two of his ribs, but he never even mentioned this at the time, and coolly went on with his work till the last man was dressed and safely removed.

He then went over to another battery and tended a wounded officer. It was only when this was done that he returned to his dug-out and reported his own injury.

Capt. Noel Godfrey Chavasse, M.C., M.B., Royal Army Medical Corps.

For most conspicuous bravery and devotion to duty.

During an attack he attended the wounded in the open all day, under heavy fire, frequently in view of the enemy. During the ensuing night he searched for wounded on the ground in front of the enemy's lines for four hours.

Next day he took one stretcher-bearer to the advanced trenches, and under heavy shell-fire carried an urgent case for 500 yards into safety, being wounded in the side by a shell splinter during the journey. The same night he took up a party of twenty volunteers, rescued three wounded men from a shell hole twenty-five yards from the enemy's trench, buried the bodies of two officers, and collected many identity discs, although fired on by bombs and machine guns.

Altogether he saved the lives of some twenty badly wounded men, besides the ordinary cases which passed through his hands. His courage and self-sacrifice were beyond praise.

War Office,
October 26, 1916.

His Majesty the King has been graciously pleased to award the Distinguished Conduct Medal to the undermentioned Non-commissioned Officers and men of No. 22nd Field Ambulance, Royal Army Medical Corps, in recognition of great devotion to duty and eminent services rendered by them when prisoners of War, during epidemics of cholera and typhus fever, at the Prisoners of War Camps in Gottingen and Ohrdruf. respectively.

No. 12402 Staff-Serjt. T. E. Rondell.
No. 170 Acting-Cpl. D. M. Newall.
No. 4586 Pte. A. Hazell.
No. 8382 Pte. H. Blackman.
No. 8653 Pte. J. Canty.
No. 8892 Pte. J. I. Robertson.

War Office,
October 27, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned Non-commissioned Officers and men:—

No. 2262 Cpl. R. H. Abercrombie, Royal Army Medical Corps.
No. 30465 Serjt. J. W. Armitage, Royal Army Medical Corps.
No. 1390 Cpl. W. Baker, Royal Army Medical Corps.
No. 6362 Pte. (Acting-Serjt.) T. H. Ballard, Royal Army Medical Corps.
No. 17794 Staff-Serjt. W. A. Beckett, Royal Army Medical Corps.

No. 20792 Cpl. J. Beesley, Royal Army Medical Corps.
No. 17363 Pte. (Acting-Lance--Serjt.) J. Bradshaw, Royal Army Medical Corps.
No. 1015 Cpl. H. Brown, Royal Army Medical Corps.
No. 31792 Pte. J. Brown, Royal Army Medical Corps.
No. 5 Qmr-Serjt. (Acting-Serjt.-Major) R. B. Brown, Royal Army Medical Corps.
No. 39326 Pte. S. H. Burke, Royal Army Medical Corps.
No. 1888 Cpl. T. Chapman, Royal Army Medical Corps.
No. 422 Serjt. W. W. Cowans, Royal Army Medical Corps.
No. 1779 Serjt. J. A. Craib, Royal Army Medical Corps.
No. 12264 Staff Serjt. W. G. Delamare, Royal Army Medical Corps.
No. 13311 Pte. (Acting-Serjt.) G. Dunlop, Royal Army Medical Corps.
No. 5017 Pte. C. E. Edge, Royal Army Medical Corps.
No. 31344 Serjt. W. T. Fairley, Royal Army Medical Corps.
No. 909 Serjt. J. H. Greenland, Royal Army Medical Corps.
No. 806 Staff-Serjt. P. H. Greenwood, Royal Army Medical Corps.
No. 1529 Pte. J. Hattersley, Royal Army Medical Corps.
No. 1663 Pte. L. J. Horsfall, Royal Army Medical Corps.
No. 18409 Staff-Serjt. F. M. Horsfield, Royal Army Medical Corps.
No. 1168 Staff-Serjt. W. Howard, Royal Army Medical Corps.
No. 31683 Lance.-Cpl. J. Hunter, Royal Army Medical Corps.
No. 1494 Pte. J. R. Kilpatrick, Royal Army Medical Corps.
No. 12272 Cpl. (Acting-Serjt.) F. King, Royal Army Medical Corps.
No. 1565 Pte. N. Kinmond, Royal Army Medical Corps.
No. 1329 Cpl. J. Malia, Royal Army Medical Corps.
No. 3195 Cpl. C. T. Martin, Royal Army Medical Corps.
No. 7173 Pte. P. MacKenzie, Royal Army Medical Corps.
No. 1787 Pte. R. Monaghan, Royal Army Medical Corps.
No. 20697 Pte. R. Mooney, Royal Army Medical Corps.
No. 11613 Coy. Qmr.-Serjt. (now Serjt.-Major) G. R. Morris, Royal Army Medical Corps.
No. 2904 Cpl. (Acting-Serjt.) G. Mossop, Royal Army Medical Corps.
No. 2018 Pte. F. S. Milligan, Royal Army Medical Corps.
No. 42961 Pte. M. Mulcahy, Royal Army Medical Corps.
No. 1804 Pte. W. O'Gorman, Royal Army Medical Corps.
No. 678 Pte. S. Palmer, Royal Army Medical Corps.
No. 17820 Serjt. H. Peckham, Royal Army Medical Corps.
No. 420 Pte. W. Powls, Royal Army Medical Corps.
No. 6753 Pte. J. Reid, Royal Army Medical Corps.
No. 32382 Serjt. F. Reynolds, Royal Army Medical Corps.
No. 36039 Cpl. J. B. Richardson, Royal Army Medical Corps.
No. 64 Cpl. T. Robertson, Royal Army Medical Corps.
No. 19537 Pte. J. Roche, Royal Army Medical Corps.
No. 5648 Serjt. E. F. Smith, Royal Army Medical Corps.
No. 9 Qmr.-Serjt. R. Smith, Royal Army Medical Corps.
No. 18799 Cpl. (Acting Serjt.) V. Smith, Royal Army Medical Corps.
No. 20439 Pte. E. Spedding, Royal Army Medical Corps.
No. 1483 Pte. F. A. Steele, Royal Army Medical Corps.
No. 3158 Cpl. L. Steele, Royal Army Medical Corps.
No. 40246 Pte. H. Thorn, Royal Army Medical Corps.
No. 10054 Pte. A. Topham, Royal Army Medical Corps.
No. 49953 Pte. W. Trembath, Royal Army Medical Corps.
No. 1294 Pte. W. E. Walton, Royal Army Medical Corps.

APPOINTMENTS, COMMISSIONS, REWARDS, ETC.

Approved by the General Officer Commanding, Salonika Army (subject to War Office approval where authority is not quoted).

Army Headquarters,
October 4, 1916.

Honours and Rewards.

Under authority granted by His Majesty the King to the General Officer Commanding, the following honours have been awarded for gallantry and devotion to duty in the field :—

Dated September 29, 1916.

MILITARY CROSS.

Capt. Charles Leopold Franklin, M.B., Royal Army Medical Corps.

DISTINGUISHED CONDUCT MEDAL.

No. 30339 Serjt. Walter Henry Gooding, Royal Army Medical Corps.

September 14, 1916.

For No. 7345 Cpl. (Acting-Serjt.) Collins, Royal Army Medical Corps, *read* No. 7345 Cpl. (Acting-Serjt.) W. J. Collins, Royal Army Medical Corps.

For No. 47320 Cpl. (Acting-Serjt.) Kingsnorth, Royal Army Medical Corps, *read* No. 47320 Cpl. (Acting-Serjt.) G. S. Kingsnorth, Royal Army Medical Corps.

ARMY MEDICAL SERVICE.

Surg-Gen. T. J. O'Donnell, C.B., D.S.O., to rank as Lieut.-Gen. whilst employed as Director of Medical Services in India, dated September 21, 1916.

ROYAL ARMY MEDICAL CORPS.

The undermentioned relinquish their temporary rank on re-posting:—
Dated July 15, 1916.—Lieut.-Col. (temp. Col.) Michael Boyle, M.B.
Dated July 20, 1916.—Lieut.-Col. (temp. Col.) Nicholas Tyacke, M.B.
Dated July 3, 1916.—Capt. (temp. Major) Philip S. Stewart.
Dated August 13, 1916.—Capt. (temp. Major) William E. Marshall.

The undermentioned to be temporary Colonels whilst Assistant Directors of Medical Services of Divisions:—
Dated July 15, 1916.—Lieut.-Col. George T. K. Maurice, C.M.G.
Dated July 20, 1916.—Lieut.-Col. William H. S. Nickerson, V.C., C.M.G., M.B.
Dated July 30, 1916.—Lieut.-Col. Frederick S. Penny, C.M.G., M.B.
Dated August 11, 1916.—Brevet-Col. Howard Ensor, D.S.O.
Dated August 20, 1916.—Lieut.-Col. Peter MacKessack, M.B.

Major Edgar E. E. Powell, from Supernumerary List, to be Lieut.-Col., *vice* Lieut.-Col. J. S. Green, placed on retired pay, dated September 26, 1916. (Substituted for the notification in the *Gazette*, dated September 28, 1916.)

Major (Temp. Lieut.-Col.) Francis S. Irvine, D.S.O., M.B., to be Lieut.-Col., *vice* Lieut.-Col. A. Kennedy, promoted, dated September 29, 1916.

Major Norman E. J. Harding, M.B., to be Temp. Lt.-Col. whilst in command of a Stationary Hospital from November 17 to 21, 1914, and from April 28 to August 10, 1916.

The undermentioned Majors (temporary Lieutenant-Colonels) relinquish their temporary rank on re-posting:—
Dated September 17, 1914.—James R. McMunn, C.M.G.
Dated October 10, 1914.—Michael Boyle, M.B.
Dated February 7, 1915.—James R. McMunn, C.M.G.
Dated November 16, 1915.—Arthur W. Gibson.
Dated May 6, 1916.—Charles D. Myles, M.B.
Dated May 30, 1916.—Mortimer J. Cromie.
Dated August 8, 1916.—George E. Ferguson.
Dated August 25, 1916.—John M. B. Rahilly, M.B.

The undermentioned Majors to be Temporary Lieutenant-Colonels whilst in command of Field Ambulances:—
Dated November 7, 1915.—Harry B. Connell.
Dated November 9, 1915.—Hugh Stewart, M.B.
Dated November 10, 1915.—Ernest B. Knox, M.D.
(Substituted for the notification in the *Gazette* of March 18, 1916.)

The undermentioned Majors to be Temporary Lieutenant-Colonels whilst in command of Stationary Hospitals:—
Dated August 5, 1914.—James R. McMunn, C.M.G.; William L. Steele.
Dated August 20, 1914.—John H. Campbell, D.S.O.
Dated September 13, 1914.—William J. Taylor, M.B.

Dated September 18, 1914.—Michael Boyle, M.B.
Dated October 11, 1914.—James R. McMunn, C.M.G.
Dated December 15, 1914.—Arthur E. Smithson, M.B.
Dated February 7, 1915.—John W. H. Houghton, M.B.
Dated March 22, 1915.—Arthur R. Greenwood.
Dated June 6, 1915.—Raymond L. V. Foster, M.B.
Dated November 12, 1915.—Sydney M. W. Meadows.
Dated December 26, 1915.—Charles R. L. Ronayne, M.B.
Dated April 1, 1916.—William J. P. Adye-Curran.
Dated April 3, 1916.—Alfred J. Hull, F.R.C.S.
Dated June 2, 1916.—Arthur W. Gater.
Dated June 24, 1916.—Philip J. Marett.
Dated July 7, 1916.—Daniel L. Harding.
Dated July 25, 1916.—George G. Tabuteau.
Dated August 5, 1916.—Harry C. Sidgwick, M.B.

The undermentioned Majors to be Temporary Lieutenant-Colonels whilst in command of Casualty Clearing Stations:—

Dated October 30, 1914.—Henry Rogers, M.B.
Dated November 6, 1914.—Jonas W. Leake, C.M.G.
Dated September 2, 1915.—Santiago L. Pallant.
Dated October 1, 1915.—Arthur W. Gibson.
Dated November 16, 1915.—Harry T. Wilson, D.S.O.
Dated February 21, 1916.—Charles D. Myles, M.B.
Dated April 10, 1916.—William R. P. Goodwin.
Dated May 17, 1916.—Robert J. Cahill, M.B.
Dated June 1, 1916.—Wallace Benson, M.B.
Dated June 2, 1916.—Richard J. C. Thompson, D.S.O.
Dated July 6, 1916.—John M. B. Rahilly, M.B.
Dated July 25, 1916.—Richard B. Hole, M.B.
Dated August 2, 1916.—Albert E. Hamilton, D.S.O.

The undermentioned Majors to be Temporary Lieutenant-Colonels whilst in command of General Hospitals:—

Dated June 28, 1915.—Horace G. Pinches.
Dated April 23, 1916.—Henry F. Shea, M.B.

The undermentioned Majors to be Temporary Lieutenant-Colonels whilst in command of Field Ambulances:—

Dated August 5, 1914.—Malcolm MacG. Rattray, M.B.
Dated September 14, 1914.—Edwin C. Hayes; Samuel A. Archer.
Dated November 14, 1914.—James H. R. Winder, M.D.
Dated November 20, 1914.—Ernest W. Bliss.
Dated January 6, 1915.—Rowland P. Lewis.
Dated September 9, 1915.—Ronald A. Bryden.
Dated October 15, 1915.—Mortimer J. Cromie.
Dated November 22, 1915.—William Bennett, M.B.
Dated December 6, 1915.—Alexander J. Williamson, M.B.
Dated December 9, 1915.—Reginald C. Wilmot.
Dated December 10, 1915.—George J. Houghton.
Dated January 6, 1916.—Henry W. Long, M.B.
Dated January 29, 1916.—Richard J. C. Thompson, D.S.O.
Deted February 8, 1916.—Frederick E. Rowan-Robinson, M.B.; Rochford N. Hunt, M.B.: Norman E. Dunkerton.
Dated March 10, 1916.—John Matthews.
Dated April 8, 1916.—David Ahern.
Dated May 27, 1916.—Charles W. Holden.
Dated May 28, 1916.—Thomas J. Wright.
Dated June 2, 1916.—Harold C. Hildreth, F.R.C.S.
Dated June 3, 1916.—George E. Ferguson.
Dated June 7, 1916.—Bernard B. Burke, D.S.O.
Dated June 18, 1916.—Gerald A. Kempthorne.
Dated August 8, 1916.—Thomas E. Harty.

The undermentioned temporary Majors to be temporary Lieutenant-Colonels whilst in command of Field Ambulances :—

Dated August 9, 1916.—Edward L. Gowlland, M.B.
Dated August 25, 1916.—William B. Edwards,

Capt. (temporary Major) Victor C. Honeybourne relinquishes his temporary rank on reposting, dated May 27, 1916.

The undermentioned Captains to be temporary Majors whilst in command of Field Ambulances :—

Dated September 15, 1915.—Mortimer J. Cromie.
Dated October 28, 1915.—George P. Taylor, M.B.
Dated November 1, 1915.—Dennis T. MacCarthy, M.B.
Dated December 1, 1915.—George B. Edwards.
Dated March 10, 1916.—Arthur D. O'Carroll, M.B.; Gerald H. Stevenson, M.B.; Percy S. Tomlinson; Benjamin Johnson, M.B.
Dated March 16, 1916.—Whiteford J. E. Bell, D.S.O., M.B.
Dated March 17, 1916.—Edward J. Kavanagh, M.B.
Dated March 27, 1916.—Charles R. M. Morris, M.B.
Dated April 10, 1916.—Frederick H. Bradley, M.B.; Ernest D. Cadell, M.B.; Donald F. Mackenzie, M.B.
Dated April 12, 1916.—William H. Forsyth, M.B.
Dated April 23, 1916.—Francis L. Bradish; Robert Hemphill, M.B.
Dated April 26, 1916.—William B. Purdon, M.B.
Dated June 2, 1916.—Gerald F. Rudkin.
Dated July 5, 1916.—Philip G. M. Elvery.
Dated July 9, 1916.—Harold Gibson.
Dated August 11, 1916.—Thomas B. Nicholls, M.B.
Dated August 12, 1916.—Thomas S. Eves, M.B.
Dated August 14, 1916.—John D. Bowie, M.B.

ARMY MEDICAL OFFICERS' WIDOWS AND ORPHANS FUND.

SUMMARY OF THE PROCEEDINGS OF THE QUARTERLY MEETING OF THE COMMITTEE WHICH WAS HELD AT THE ROYAL ARMY MEDICAL COLLEGE ON JULY 20, 1916.

Present:

Deputy Surgeon-General W. G. Don, Vice-President, in the Chair.
Colonel D. Wardrop, C.V.O.
Lieut.-Col. J. More Reid.
Major G. S. Mansfield.
The Secretary.

Major G. S. Mansfield took his seat on the Committee, under Rule XXVI.

The minutes of the previous meeting were read and confirmed.

The deaths were reported of Mrs. C. N. Fowle Smith and Mrs. M. L. C. Clifton, first-class annuitants.

Major (temp. Lieut.-Col.) W. D. C. Kelly was admitted a first-class married member at annual subscription of £17 2s. 5d., together with an additional annual payment of £52 10s. as long as the war continues.

A certificate from the Actuary was submitted that the marketable securities of the Society were "Trustee" stocks on June 30, 1916.

It was resolved that a special additional fee of ten guineas be paid to Mr. Andras for the extra work involved in his recent quinquennial valuation of the liabilities of the Society.

The question having been raised, informally, at the last General Meeting, as to whether it might be possible to reduce the extra war charge of £52 10s. per annum now made, the Secretary submitted a report from the Actuary. The latter stated that since the Committee had decided, on his recommendation, to impose the present extra premium, such Life Assurance Offices as have not declined altogether to accept new war risks have very considerably increased their extra premiums, as compared with

those charged at that time. He is of opinion that the present extra charge made by the Society should be maintained. After full consideration the Committee resolved that it was not advisable that any change be made at present.

The SECRETARY reported that an additional £300 out of cash balances at the bank had been invested in Exchequer Bonds 5 per cent. The total holding of these bonds now amounts to £1,000.

The question was considered of transferring the War Stock (£10,000) and Exchequer Bonds (£1,000) held by the Society from the books of the Bank of England to those of the Post Office, whereby further transfer in the case of change of Trustees would be avoided. It was resolved that this be done, subject to the approval of the Trustees and Bankers of the Society.

The case was considered of a member of the Society who had, inadvertently, continued his subscription as a married member for some years after the death of his wife. It was resolved that the Secretary be authorized to refund to him a sum equivalent to these subscriptions should no objection be raised by the professional advisors of the Society.

The Secretary submitted an acknowledgment from one of the Trustees that the insurance premium on a sum of £500 had been paid by him to the Guarantee Society for the current year.

Payment of the Secretary's salary and office allowance for the quarter ended June 30 was sanctioned, and refund to him of petty cash expended; also payment of £13 5s. 6d. for printing.

Homefield Road,
Wimbledon, S.W.

J. T. CLAPHAM (*Captain*),
Secretary.

AUXILIARY R.A.M.C. FUNDS.

LIST OF DONATIONS RECEIVED FOR THE OFFICERS' BENEVOLENT BRANCH, UP TO OCTOBER 6, 1916.

	£	s.	d.
"From a Friend" (per Sir. Wm. Osler)	100	0	0
Lieut.-Col. W. Collier	52	10	0
Major W. F. Brook	52	10	0
Lieut.-Col. W. Hale White	52	10	0
Lieut.-Col. H. G. Barling	50	0	0
Lieut.-Col. F. W. Westmacott	21	0	0
Major Ewen Maclean	21	0	0
Major A. C. Farquharson	20	0	0
Capt. A. A. Young	15	0	0
Capt. Hugh F. Wickens	10	10	0
Lieut.-Col. Sir James Barr	10	10	0
Lieut.-Col. Geo. S. Middleton	10	10	0
Capt. Cholmondley Webb	10	10	0
Major T. K. Monro	10	10	0
Major T. W. Buckley	10	10	0
Capt. Hugh H. Weir	10	10	0
Lieut.-Col. T. Gowans	10	10	0
Surg.-Gen. Sir G. H. Makins, K.C.M.G., C.B.	10	10	0
Capt. D. Douglas Crawford	10	0	0
Per Sir Wm. Osler	10	0	0
Col. Sir J. Rose Bradford, K.C.M.G., C.B.	5	5	0
Col. W. Coates	5	5	0
Lieut.-Col. G. A. Bannatyne	5	5	0
Lieut.-Col. Norman Dalton	5	5	0
Capt. Edgar Grey	5	5	0
Capt. V. Rich	5	5	0
Capt. E. F. Buzzard	5	5	0
Capt. H. R. Vachell	5	5	0
Lieut.-Col. Claude Douglas	5	5	0
Capt. R. P. Rowlands	5	5	0
Lieut.-Col. W. F. Haslam	5	5	0
Capt. W. B. Warrington	5	5	0
Capt. A. Blackwell	5	5	0
Lieut.-Col. B. L. Hamilton	5	5	0
Surg.-Col. Atwood Thorne, V.D.	5	5	0
Major H. H. Littlejohn	5	5	0
Lieut.-Col. W. Pasteur	5	5	0
Major D. W. Patterson	5	5	0
Major J. W. Leech	5	5	0
Lieut.-Col. W. G. Richardson	5	5	0
Capt. F. W. Wilson	5	5	0
Lieut.-Col. A. M. Martin	5	5	0
Lieut.-Col. H. B. Angus	5	5	0
Dr. A. Duke	5	5	0
Major J. D. Wardale	5	5	0
Major A. Parkin	5	5	0
Major R. P. R. Tyle	5	5	0
Lieut.-Col. T. Beattie	5	5	0
Col. D. J. Mackintosh, M.V.O.	5	0	0
Capt. H. H. Kendrick	5	0	0
Capt. H. Gordon Oliver	5	0	0
Capt. H. H. Elliot	5	0	0
Lieut.-Col. H. P. Hawkins	5	0	0
Lieut.-Col. W. F. Roe, D.S.O.	5	0	0
Capt. Ed. Mackay	4	4	0
Lieut.-Col. Mansel Moullin	4	4	0
Capt. T. V. Mills	3	3	0

	£	s.	d.
Capt. Leslie H. Walsh ..	3	3	0
Lieut. A. P. Gibbons	3	3	0
Lieut.-Col. R. A. Bolam ..	3	3	0
Capt. T. H. Livingstone ..	3	3	0
Major F. C. Pybus	3	3	0
Major W. D. Arnison	3	3	0
Capt. H. J. Slade	3	3	0
Capt. W. T. Harkness	3	3	0
Capt. V. H. Blake	2	2	0
Major G. Newton Pitt	2	2	0
Capt. C. E. Droop	2	2	0
Capt. Robert Thompson ..	2	2	0
Capt. W. Seymour	2	2	0
Capt. G. F. Armstrong ..	2	2	0
Capt. W. B. Gourlay	2	0	0
Major T. S. Toogood	1	1	0
Major W. W. Jones	1	1	0
Capt. Slater	1	1	0
Capt. Menzies	1	1	0
Capt. Lickley	1	1	0
Lieut. P. E. Murray	1	1	0
Lieut. H. O. Wheeler	1	1	0
Lieut. W. B. Anderson ..	1	1	0
Lieut. and Qmr. Gibbs ..	1	1	0
	£731	1	0

ROYAL ARMY MEDICAL CORPS CENTRAL MESS FUND.

Honorary Secretaries of permanently established Messes are reminded that officers subscribing to the above Fund, and honorary members thereof, are relieved of all joining contributions to such Messes, including those paid on promotion. The payment of these is a charge on the Central Mess Fund and application for the sums due should be made quarterly to the Hon. Secretary.

3, *Homefield Road,*
Wimbledon, S.W.

J. T. Clapham, *Captain,*
Hon. Secretary.

ARMY MEDICAL OFFICERS' WIDOWS AND ORPHANS FUND.

Summary of the Proceedings of a Quarterly Meeting of the Committee held at the Royal Army Medical College on October 26, 1916.

Major P. S. O'Reilly took his seat on the Committee under Rule XXVI.

The Minutes of the previous Meeting were read and confirmed.

Payment of annuities on the lists submitted was sanctioned, as was the withdrawal of £600 from deposit with the National Debt Commissioners, to pay annuitants on the Old Account.

The Secretary reported that the £10,000 War Stock 4½ per cent, and £1,000 Exchequer Bonds, five per cent, held by the Society had been transferred from the books of the Bank of England to those of the Post Office Savings Bank, as resolved at the previous meeting.

His Majesty's Government having asked for the deposit with the Treasury of certain securities, under the Regulation of Foreign Exchanges Act, it was resolved that the £5,500 Dominion of Canada 3½ per cent Stock held by the Society be so deposited, subject to the approval of the Trustees.

A widower member of the Society having, through inadvertence, continued his subscription as a married member for several years since the death of his wife, refund of such subscriptions to him was sanctioned.

Payment of the Secretary's salary and office allowance for the past quarter was sanctioned.

As the Secretary from time to time receives enquiries as to the present conditions of admission to the Society, he would again draw attention to the fact that no new members are admitted except at an extra charge for war risks of 50 guineas per annum, in addition to the normal annual subscription according to scale. Membership is limited to officers on the strength of the Corps at the outbreak of war. In the event of the declaration of peace shortly after payment of this extra premium, the consulting Actuary to the Society recommends the refund of a part of it to the member, in proportion to the risk unincurred.

The Committee have recently considered the possibility of reducing this extra charge, but in view of a special report from the Actuary on the matter do not consider any reduction advisable.

3, *Homefield Road,*
Wimbledon, S.W.

J. T. Clapham, *Captain,*
Hon. Secretary.

ROYAL ARMY MEDICAL COLLEGE.

LIST OF BOOKS ADDED TO THE LIBRARY DURING THE MONTHS OF JULY, AUGUST AND SEPTEMBER, 1916.

Title of Work and Author	Edition	Date	How obtained
Milk and its Hygienic Relations. By Janet E. Lane-Claypon, M.D.		1916	Library Grant.
Nerve Injuries and their Treatment. By Purves Stewart and A. Evans		1916	,, ,,
Chemical Technology of Oils, Fats and Waxes. By Dr. J. Lewkowitsch. 3 vols	5th	1914-15	,, ,,
The Involuntary Nervous System. By W. H. Gaskell, M.A., M.D., F.R.S.		1916	,, ,,
The Respiratory Exchange of Animals and Man. By A. Keogh, Ph.D.		1916	,, ,,
The Medical Annual		1916	,, ,,
The After-treatment of Operations. By P. L. Mummery	4th	1916	,, ,,
The Endocrine Organs. By Sir E. A. Schäfer, F.R.S.		1916	,, ,,
Diseases of the Nose and Throat. By Sir St. Clair Thomson, M.D.	2nd	1916	,, ,,
The Pathology of Tumours. By E. H. Kettle, M.D.		1916	,, ,,
On Modern Methods of treating Fractures. By E. W. Hey Groves, M.S., M.D.		1916	,, ,,
Serums, Vaccines and Toxins. By W. C. Bosanquet and John W. H. Eyre	3rd	1916	,, ,,
A History of the Indian Medical Service, 1600-1913. By Lt.-Col. D. G. Crawford, I.M.S.(Ret.). 2 vols.		1914	,, ,,
Localization by X-Rays and Stereoscopy. By Sir J. Mackenzie Davidson		1916	,, ,,
Animal Parasites of Man. By Fantham, Stephens and Theobald		1916	,, ,,
Organische Chemie. By V. v. Richter. New Edition by Anchutz and Muswein. 2 vols		1909-13	,, ,,
Report of the Librarian of Congress		1915	Editor, Journal.
St. Bartholomew's Hospital Reports, 1915		1916	,, ,,
Wound Infections. By Col. Sir A. E. Wright, F.R.S.		1915	,, ,,
Gunshot Injuries of Bones. By Capt. E. W. Hey Groves, R.A.M.C.(T.)		1915	,, ,,
Modern Bone-setting for the Medical Profession. By Frank Rower		1915	,, ,,
Reports, Yellow Fever Commission (West Africa). Vol. iii		1916	,, ,,
Reports, Yellow Fever Commission, Fourth and Final Report		1916	,, ,,
The Bacteriology of Dysentery in Malaya. By Henry Fraser, M.D.		1916	,, ,,
Kriegschirurgisches Handbuch. Von Dr. Richard Fibich		1915	Director-General, A.M.S.
Die Behandlung von Kriegsverletzungen und Kriegskrankheiten in dem Heimatlazaretten. 2 vols.		1915-16	,, ,,
Kriegschirurgische Tatigkeit. Von L. Dreyer ..		1916	,, ,,
Report on the Medico-Military Aspects of the European War. By Surgeon A. M. Fauntleroy, U.S. Navy		1915	,, ,,
Roll of Honour Royal College of Surgeons in Ireland		1914-15	,, ,,

LIST OF BOOKS ADDED TO THE LIBRARY—*Continued.*

Title of Work and Author	Edition	Date	How obtained
Über Schädelschüsse. Von Dr. Rudolf Allers ..		1916	War Office.
Atlas der Kriegsaugenheilkunde. Von Prof. Dr. A. von Szily		1916	,, ,,
Journal of the Royal Naval Medical Service. Vol. ii. No. 3, July, 1916		1916	Presented by the Editor.
The Geographical Journal, April to July		1916	Presented by Colonel R. J. S. Simpson, C.M.G.
Vaccination, its Natural History and Pathology. By S. Monckton Copeman, M.A., M.D., &c.		1899	Presented by the Author.
Metropolitan Borough of Poplar. Annual Report for the year 1915		1916	Presented by the Medical Officer of Health.
Légendes et Curiosities de l'Histoire. Par le Docteur Cabanes. 2 vols.		No date	Presented by Major W. G. K. Barnes, R.A.M.C.(Temp.).
Report of the 85th Meeting of the British Association for the Advancement of Science. Manchester, 1915, September 7-11		1916	Presented by Surgeon-General Sir D. Bruce, C.B., F.R.S.
The R.A.M.C. Depot Magazine. Vol. 1		1916	Presented by the Editor.
Recollections by Surgeon-Major George A. Hutton, Honorary Organizing Commissioner, St. John's Ambulance Association. (Pamphlet)		1916	Presented by Lieut.-Colonel G. E. Twiss, R.A.M.C.
The Parliament of the Commonwealth of Australia, Department of Trades and Customs. Report of the Committee concerning the Causes of Death and Invalidity in the Commonwealth. Preliminary Report, 1914-15-16		1916	
Report on Typhoid Fever, 1914-15-16		1916	
Report on Risks of Middle Age		1916	Chairman of the Committee.
Report on Venereal Diseases		1916	

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

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Any demand for excerpts, additional to the above, or for reprints, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates :—

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	16	0	8	3	0	3	11								
25	4	0	3	4	0	1	5								
	8	0	6	0	0	2	9	4	10	1	6	4	4	0	11
	16	0	10	6	0	5	0								
50	4	0	4	6	0	1	10								
	8	0	7	6	0	3	6	5	0	2	1	4	10	1	2
	16	0	13	3	0	5	10								
100	4	0	6	0	0	3	1								
	8	0	10	0	0	4	10	7	10	3	11	6	7	2	5
	16	0	18	6	0	7	6								
200	4	0	9	6	0	4	5								
	8	0	15	0	0	6	7	10	10	7	6	9	0	4	10
	16	1	6	0	0	9	8								

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Cases for Binding Volumes.—Strong and useful cases for binding can be obtained from the publishers at the undermentioned rates:—

Covers, 1s. 8d. net; binding, 1s. 6d.

These charges are exclusive of cost of postage.

In forwarding parts for binding the name and address of sender should be enclosed in parcel.

All Applications for Advertisements to be made to—

G. STREET & CO., Ltd., 8, Serle Street, London, W.C.

The back outside cover is not available for advertisements.

The above figures are subject to 15 per cent. increase.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

All such Communications or Articles accepted and published in the "Journal of the Royal Army Medical Corps" will (unless the Author notifies at the time of submission that he reserves the copyright of the Article to himself) become the property of the Library and Journal Committee, who will exercise full copyright powers concerning such Articles.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," War Office, Whitehall, London, S.W.

Communications have been received from Lieut.-Col. E. J. Williams; Major F. C. Pybus; Captains J. B. Fisher, W. Fletcher, F. S. Hawkes, T. J. Mackie, J. A. Pringle, R. J. Stirling, and C. P. Symonds; Lieutenants A. M. Kennedy and D. D. Rosewarme; F. E. Taylor, Esq., M.D.

The following publications have been received:—

British: Medical Press and Circular, The Journal of Tropical Medicine and Hygiene, St. Bartholomew's Hospital Journal, The Hospital, The Lancet, The Medical Journal of Australia, The Royal Engineers' Journal, The Medical Review, The Indian Medical Gazette, The Medical Journal of South Africa, Annals of Tropical Medicine and Parasitology, Guy's Hospital Gazette, The Journal of State Medicine, Public Health, The Practitioner, The St. Thomas's Hospital Gazette, Commonwealth of Australia (Quarantine Service), Tropical Veterinary Bulletin, Tropical Diseases Bulletin, Journal of the Royal Naval Medical Service, Report of the Director-General of Public Health (New South Wales), The Middlesex Hospital Journal, The British Journal of Tuberculosis, Proceedings of the Royal Society of Medicine, The R.A.M.C. Depot Magazine, The Army Service Corps Journal, The Quarterly Review, Journal of No. 10 *Stationary Hospital.*

Foreign: Bulletin de l'Institut Pasteur, Russian Naval Medical Journal, Archives de Médecine et de Pharmacie Militaires, United States Public Health Service, United States Naval Medical Bulletin, The Journal of Infectious Diseases, Bulletin of the Johns Hopkins Hospital, Le Caducée, l'Ospedale Maggiore, Archives de l'Inst. Pasteur de Tunis, Bulletin de la Société de Pathologie Exotique, Reprint of the United States Journal of Agriculture Research, Office International D'Hygiene Publique, The Philippine Journal of Science, Giornale di Medicina Militare, Archives de Medecine et Pharmacie Navales.

MANAGER'S NOTICES.

The JOURNAL OF THE ROYAL ARMY MEDICAL CORPS is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

THE HON. MANAGER,
"JOURNAL OF THE ROYAL ARMY MEDICAL CORPS,"
WAR OFFICE, WHITEHALL, S.W.

JOURNAL

OF THE

ROYAL ARMY MEDICAL CORPS.

Corps News.

DECEMBER, 1916.

APPOINTMENTS, COMMISSIONS, REWARDS, ETC.

Approved by the Commander-in-Chief, Egyptian Expeditionary Force.

LIST No. 216.

General Headquarters,
October 20, 1916.

HONOURS AND REWARDS.

His Majesty the King of Serbia has, with the approval of H.M. the King, bestowed the following Decorations on the undermentioned Officers and men of the Mediterranean Expeditionary Force or who have served or are now serving in Egypt and Salonika, in recognition of their distinguished service during the Campaign.

There are no restrictions as to the occasions on which any of these decorations may be worn.

Silver Star, 2nd Class.

No. 16573 Serjt.-Major Robert Stewart Nichol, 25th Casualty Clearing Station, Royal Army Medical Corps.

Gold Medal.

No. 39738 Pte. Andrew Gowans, 32nd Field Ambulance Royal Army Medical Corps.

Silver Medal.

No. 40340 Pte. George Murdoch, 32nd Field Ambulance, Royal Army Medical Corps.

No. 53051 Pte. (now Acting-Cpl.) Michael Carroll, 25th Casualty Clearing Station, Royal Army Medical Corps.

EXTRACTS FROM THE "LONDON GAZETTE."

War Office,
November 1, 1916.

ADDITIONAL MENTIONS IN DISPATCHES.

The following names are added to the list of Officers and men mentioned for distinguished and gallant services in General Sir Ian Hamilton's Dispatch of December 11, 1915 (published in the *London Gazette*, No. 29455, dated January 28, 1916).

Royal Naval Division.

Capt. F. Casement, M.B., Royal Army Medical Corps.

The following names are added to the list of Officers and men mentioned for distinguished and gallant services by General Sir Charles Monro, in his Dispatch dated March 6, 1916 (published in the *London Gazette*, No. 29664, dated July 13, 1916).

Royal Army Medical Corps.

Capt. A. J. Horne.
Temp. Hon. Capt. W. T. Thomas, Royal Army Medical Corps.
Temp. Lieut. H. E. Brawn (since relinquished his commission).
Hon. Lieut. and Qmr. J. H. McClelland.
No. 1868 Serjt. (Acting-Serjt.-Major) E. B. Browne.
No. 24616 Serjt. J. M. Peart.
No. 31786 Cpl. G. F. Bray.
No. 55475 Pte. C. E. Anstis.
No. 56510 Pte. E. Bootle.
No. 27103 Pte. S. Bryan.
No. 55489 Pte. A. F. Ogle.

The following name is added to the list of Officers and men mentioned for special services by General Sir Reginald Wingate in his Dispatch of August 8, 1916 (published in the *London Gazette*, No. 29800, dated October 25, 1916).

Staff and Administrative Services.

Gibbon, Capt. E., M.B., Royal Army Medical Corps.

War Office,
November 11, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the Field to the undermentioned Non-commissioned Officers and Men:—

No. 50241 Pte. S. J. Adams, Royal Army Medical Corps.
No. 40911 Pte. W. Arthur, Royal Army Medical Corps.
No. 2372 Cpl. D. G. Ashlin, Royal Army Medical Corps.
No. 42403 Staff-Serjt. F. M. Ault, Royal Army Medical Corps.
No. 20013 Lance-Cpl. (Acting-Cpl.), A. Avery, Royal Army Medical Corps.
No. 18427 Staff-Serjt. (now Qmr.-Serjt.) P. Barber, Royal Army Medical Corps.
No. 42407 Serjt. J. Barratt, Royal Army Medical Corps.
No. 2766 Serjt. A. G. Barrett, Royal Army Medical Corps.
No. 42412 Cpl. J. Barrett, Royal Army Medical Corps.
No. 1759 Cpl. E. A. Bastin, Royal Army Medical Corps.
No. 596 Staff-Serjt. W. J. Bastone, Royal Army Medical Corps.
No. 19827 Serjt. J. W. Baxter, Royal Army Medical Corps.
No. 20355 Acting-Cpl. A. Biggs, Royal Army Medical Corps.
No. 1921 Serjt. E. H. Blanthorn, Royal Army Medical Corps.
No. 277 Staff-Serjt. W. Boswell, Royal Army Medical Corps.
No. 42405 Pte. H. Brindle, Royal Army Medical Corps.
No. 41610 Staff-Serjt. F. E. F. Brown, Royal Army Medical Corps.
No. 37820 Pte. F. Burgess, Royal Army Medical Corps.
No. 11734 Staff-Serjt. A. H. O. Campion, Royal Army Medical Corps.
No. 1968 Driver W. H. Carne, Royal Army Medical Corps.
No. 1401 Staff-Serjt. P. W. Carter, Royal Army Medical Corps.
No. 1898 Cpl. H. Chantrell, Royal Army Medical Corps.
No. 61618 Acting Staff-Serjt. B. Child, Royal Army Medical Corps.
No. 1703 Cpl. G. Cole, Royal Army Medical Corps.
No. 16190 Staff-Serjt. J. R. Cowling, Royal Army Medical Corps.
No. 41157 Lance-Cpl. R. Craig, Royal Army Medical Corps.
No. 2245 Serjt. A. G. Cripps, Royal Army Medical Corps.
No. 1811 Serjt. R. E. J. Currell, Royal Army Medical Corps.
No. 1995 Cpl. S. T. Deacon, Royal Army Medical Corps.
No. 42434 Pte. J. Dimond, Royal Army Medical Corps.
No. 19746 Serjt. W. F. Dodwell, Royal Army Medical Corps.
No. 1953 Pte. A. English, Royal Army Medical Corps.
No. 1844 Pte. W. J. Fryer, Royal Army Medical Corps.
No. 41328 Pte. W. George, Royal Army Medical Corps.
No. 980 Staff-Serjt. W. D. Gibb, Royal Army Medical Corps.
No. 1323 Staff-Serjt. J. D. Gilbert, Royal Army Medical Corps.
No. 7932 Pte. A. R. Gilbertson, Royal Army Medical Corps.
No. 40988 Staff-Serjt. R. S. Gillespie, Royal Army Medical Corps.
No. 5814 Acting-Cpl. W. Glen, Royal Army Medical Corps.

No. 45 Staff-Serjt. J. Gratton, Royal Army Medical Corps.
No. 41307 Pte. R. S. Greenfield, Royal Army Medical Corps.
No. 60781 Serjt. W. A. Hadden, Royal Army Medical Corps.
No. 4676 Pte. A. Hadfield, Royal Army Medical Corps.
No. 1393 Lance-Cpl. G. Harrison, Royal Army Medical Corps.
No. 63512 Serjt. J. Harvey, Royal Army Medical Corps.
No. 4567 Pte. R. Hockheimer, Royal Army Medical Corps.
No. 41175 Pte. J. G. Holmes, Royal Army Medical Corps.
No. 10719 Qmr.-Serjt. W. H. Hopwood, Royal Army Medical Corps.
No. 5 Qmr.-Serjt. (Acting-Serjt.-Major) A. E. R. House, Royal Army Medical Corps.
No. 5296 Pte. A. O. Howard, Royal Army Medical Corps.
No. 794 Cpl. W. J. Howell, Royal Army Medical Corps.
No. 19187 Pte. C. V. Hunt, Royal Army Medical Corps.
No. 9189 Pte. W. Julien, Royal Army Medical Corps.
No. 58180 Cpl. A. D. Kirkham, Royal Army Medical Corps.
No. 8307 Pte. J. Lee, Royal Army Medical Corps.
No. 42490 Serjt. C. S. Mackay, Royal Army Medical Corps.
No. 1270 Cpl. (Acting-Serjt.) F. G. Marralle, Royal Army Medical Corps.
No. 41966 Pte. F. May, Royal Army Medical Corps.
No. 64498 Acting-Serjt. C. H. Maycock, Royal Army Medical Corps.
No. 2063 Pte. D. T. Y. Middleton, Royal Army Medical Corps.
No. 2237 Pte. T. H. Newberry, Royal Army Medical Corps.
No. 65130 Cpl. F. Nunn, Royal Army Medical Corps.
No. 34568 Pte. E. E. Oxley, Royal Army Medical Corps.
No. 65762 Pte. G. Payne, Royal Army Medical Corps.
No. 2003 Serjt. W. Pearce, Royal Army Medical Corps.
No. 1979 Lance-Cpl. A. V. Pemberthy, Royal Army Medical Corps.
No. 898 Staff-Serjt. (Acting-Serjt.-Major) S. C. Pocock, Royal Army Medical Corps.
No. 1917 Lance-Cpl. L. G. Powell, Royal Army Medical Corps.
No. 6327 Acting-Cpl. F. J. Puxty, Royal Army Medical Corps.
No. 897 Acting-Staff-Serjt. S. G. Rex, Royal Army Medical Corps.
No. 1616 Lance-Cpl. T. Salisbury, Royal Army Medical Corps.
No. 399 Pte. W. Shepherd, Royal Army Medical Corps.
No. 398 Serjt. G. E. Smith, Royal Army Medical Corps.
No. 2475 Pte. E. Southgate, Royal Army Medical Corps.
No. 17633 Qmr.-Serjt. R. Sproule, Royal Army Medical Corps.
No. 9341 Pte. A. Stevington, Royal Army Medical Corps.
No. 37863 Pte. G. W. Stewart, Royal Army Medical Corps.
No. 965 Serjt. W. G. Stewart, Royal Army Medical Corps.
No. 5450 Cpl. (Acting-Serjt.) W. J. Tapp, Royal Army Medical Corps.
No. 1350 Staff-Serjt. R. Turner, Royal Army Medical Corps.
No. 2025 Pte. H. W. Vere, Royal Army Medical Corps.
No. 8347 Pte. T. Watkinson, Royal Army Medical Corps.
No. 2369 Lance-Cpl. C. H. Wells, Royal Army Medical Corps.
No. 72118 Pte. H. W. Whiting, Royal Army Medical Corps.
No. 2293 Acting-Lance-Cpl. W. Wilkinson, Royal Army Medical Corps.
No. 49804 Serjt. T. Wilson, Royal Army Medical Corps.
No. 33898 Pte. P. G. Wood, Royal Army Medical Corps.
No. 153 Staff-Serjt. S. R. Wood, Royal Army Medical Corps.
No. 1875 Pte. R. Woodgate, Royal Army Medical Corps.

His Majesty the King has been graciously pleased to award the Meritorious Service Medal to the undermentioned Warrant Officer, Non-commissioned Officers and Men, in recognition of valuable services rendered with the Armies in the field during the present War:—

No. 18226 Staff-Serjt. L. V. Bibee, Royal Army Medical Corps.
No. 66 Pte. F. H. Chick, Royal Army Medical Corps.
No. 629 Staff-Serjt. (Acting-Serjt.-Major) J. Clough, Royal Army Medical Corps.
No. 107 Serjt. S. G. De Barre, Royal Army Medical Corps.
No. 8477 Qmr.-Serjt. G. G. Gregson, Royal Army Medical Corps.
No. 51524 Staff-Serjt. R. Hall, Royal Army Medical Corps.
No. 2147 Staff-Serjt. W. C. Hampson, Royal Army Medical Corps.
No. 1097 Staff-Serjt. R. Herbert, Royal Army Medical Corps.
No. 36116 Pte. H. Hibbert, Royal Army Medical Corps.

No. 10634 Serjt. F. Horn, Royal Army Medical Corps.
No. 1268 Cpl. J. Jones, Royal Army Medical Corps.
No. 27253 Serjt. J. Orr, Royal Army Medical Corps.
No. 19126 Serjt. F. H. Perkins, Royal Army Medical Corps.
No. 5605 Cpl. A. T. Rose, Royal Army Medical Corps.
No. 18645 Qmr.-Serjt. C. E. Rouse, Royal Army Medical Corps.
No. 8292 Pte. (Acting-Serjt.) J. W. Sloan, Royal Army Medical Corps.

War Office,
November 14, 1916.

The following dispatch from Lieut-Gen. Sir Percy Lake, K.C.B., relative to the operations in Mesopotamia subsequent to April 30, 1916, has been received from the Government of India for publication.

In forwarding this dispatch to the Government of India the Commander-in-Chief expressed his appreciation of the zeal and perseverance with which Sir Percy Lake faced and energetically improved the difficult conditions encountered by him during the tenure of his command :—

General Headquarters,
Indian Expeditionary Force "D,"
August 27, 1916.

From Lieut.-Gen. Sir P. H. N. Lake, K.C.B., K.C.M.G., Commanding Indian Expeditionary Force "D." To the Chief of the General Staff, Army Headquarters, India, Simla.

Sir,—On relinquishing command of Indian Expeditionary Force "D" I have the honour to submit a short dispatch, dealing with the operations of this Force since the fall of Kut on April 30, and also describing in general terms the work carried out at the base and on the line of communications up to the present date.

OPERATIONS.

I am much indebted to Surg.-Gen. F. H. Treherne for the valuable assistance he has consistently rendered since his arrival in the country; also to Col. W. H. Willcox, Consulting Physician, whose high professional knowledge has always been at the service of the Force. Much credit is due to the Nursing Sisters, who have carried out their duties with great devotion, and have shown untiring zeal and energy in alleviating the sufferings of those who have passed through their hands.

By the untimely death of Col. Sir V. Horsley, both the Force and the medical profession sustained a severe loss.

LIST OF OFFICERS BROUGHT TO NOTICE.

Fell, Bt.-Col. M. H. G., Royal Army Medical Corps.

War Office,
November 14, 1916.

His Majesty the King has been graciously pleased to approve of the appointments of the undermentioned officers to be Companions of the Distinguished Service Order, in recognition of their gallantry and devotion to duty in the field :—

Temp. Capt. George Douglas Ferguson, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire, bringing in over fifty wounded men, and displaying the greatest courage and determination. His fearless bearing set a fine example.

Major Lewis Wibmer Jeffries, Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He tended the wounded and reorganized the stretcher-bearers in the front line at great personal risk. When only a few bearers were left, he himself assisted to carry back the wounded under heavy fire.

Lieut.-Col. Ethelbert Brown Hardy, Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He controlled the evacuation of the sick and wounded, and by his energy and courage kept up the spirits of the stretcher-bearers when they were much exhausted.

Lieut.-Col. Harry Merville Jacques, Army Medical Corps.

For conspicuous gallantry and devotion to duty. He supervised the clearing of the front and controlled the work of the advanced main dressing stations with great skill and personal courage.

The undermentioned have been awarded a Bar to their Distinguished Service Order for subsequent acts of conspicuous gallantry:—

Temp. Capt. Hugh Llewellyn Glyn Hughes, D.S.O., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. On four separate days he showed an utter contempt for danger when collecting and tending the wounded under heavy shell-fire.

(The Distinguished Service Order was awarded in *London Gazette* dated August 25, 1916.)

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers in recognition of their gallantry and devotion to duty in the field:—

Temp. Capt. Malcolm King Acheson, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire, displaying great courage and determination. By his devotion and initiative he was instrumental in saving many lives.

Temp. Capt. John Alban Andrews, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He tended the wounded with utter disregard of personal danger, dressing their wounds under heavy sniping fire from a trench 450 yards distant. He also got the wounded into shell-holes till they could be collected after dark.

Capt. James Elliot Black, M.B., Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty in action. He rendered valuable services when attending the wounded under heavy machine gun and shell-fire. Later, he went out into "No Man's Land" to succour the wounded.

Capt. Austin Basil Clarke, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He showed great coolness during the assault and for thirty hours afterwards under intense shell and machine gun fire. He tended the wounded in the open the whole time, his aid post being full, and, after dark, went out and searched the wood under heavy shell fire.

Temp. Lieut. Sydney John Darke, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. Although badly wounded he worked for five and a half hours under heavy shell-fire, tending the wounded, without letting anyone know he was wounded himself. His gallantry throughout the operation was very fine.

Capt. Henry Bryan Frost Dixon, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He volunteered, and led a stretcher-party to a regimental aid post under very heavy fire, and successfully brought in twenty-five wounded men.

Temp. Lieut. John Beatson Dunning, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. He went into the open under heavy shell fire, and tended the wounded until he was himself severely wounded.

Temp. Lieut. William Norman Gilmour, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He gallantly dressed a wounded man lying in "No Man's Land," and finally brought him in, with great courage, under very heavy fire.

Temp. Lieut. Robert Inkerman Harris, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. He commanded the stretcher-bearers throughout the entire day under incessant fire, and set a fine example of energy and pluck.

Temp. Capt. Frank Melville Harvey, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty during operations. He repeatedly tended the wounded in the open under very heavy fire, and worked continuously for thirty-six hours, showing an utter disregard of danger.

Temp. Capt. Richard Harold Hodges, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He organized and led parties of stretcher-bearers under heavy fire, displaying great courage and determination.

Temp. Capt. Edward Sandwith Johnson, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. Although severely wounded, he remained at his aid post and continued to dress the wounded with great skill and determination. He has previously done splendid work.

Capt. John Herbert Jordan, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. Under very heavy fire, he reconnoitred the front area for wounded, and by his gallantry was instrumental in recovering many wounded men from shell-holes.

Temp. Capt. John Macintyre, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under heavy fire with great courage and determination, himself being four times buried by shells.

Capt. William Edward Marshall, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire with great courage and determination. On one occasion he worked single-handed for over twenty-four hours.

Capt. William Archibald Miller, D.S.O., Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty. He accompanied a raiding party with his stretcher-bearers and remained in the enemy trenches until quite certain no raiders were left behind. Previously he had accompanied a patrol under heavy fire, and tended the wounded. He has on many previous occasions displayed great gallantry and determination.

Temp. Capt. John Hay Moir, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. Although wounded, he tended the wounded under very heavy fire, displaying great courage and determination, and refusing to be relieved until all the wounded had been evacuated.

Temp. Capt. Patrick Joseph O'Reilly, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded under intense fire, displaying great courage and determination. Later, although wounded, he stuck to his post.

Temp. Capt. Wyndham Parker, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire for thirty-six hours, displaying great courage and determination. Later, he rescued wounded officers under intense fire.

Temp. Capt. William Henry Parsons, M.D., Royal Army Medical Corps.

For conspicuous gallantry in action. He established the most advanced aid post of the brigade front, and. although slightly wounded, cleared over 300 cases. Subsequently working all night, he cleared in all 400 cases.

Capt. Edward Phillips, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He collected wounded under heavy shell, rifle and machine-gun fire. He set a fine example by his complete disregard of danger.

Temp. Capt. James Henry Ritchie, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded and organized stretcher parties under very heavy fire, displaying great courage and determination.

Capt. Hugh Huntley Robinson, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded with great courage and skill, quite regardless of personal danger. He has, on many previous occasions displayed the greatest bravery.

Temp. Lieut. Clifford Maunsell Scott, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended wounded with great skill and determination, under intense fire. He has done fine work on many previous occasions.

Temp. Capt. John Telfer Smeall, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended wounded with great skill and determination under intense fire. He has done fine work on many previous occasions.

Temp. Lieut. Frederick James Strachan, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under heavy fire, with great courage and determination. Later, although himself wounded, he continued to carry out his fine work.

Capt. John Ronald Rigden Trist, Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under heavy fire, with great courage and determination. He has on many previous occasions done fine work.

Temp. Capt. Gideon Walker, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in action. This officer cleared the wounded of the battalion with remarkable efficiency. In addition, he worked for two days under heavy and continuous shell-fire evacuating wounded.

Capt. Archibald Wilson, M.B., Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty. He organized and led parties of stretcher-bearers under very heavy fire, displaying great courage and determination. He has on many previous occasions done fine work.

Temp. Lieut. Clarence Randolph Young, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire, displaying great courage and determination.
Capt. Charles Christopher Corlis, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire with great courage and determination, working continuously for three days and nights.
Capt. William Wallace Stewart Johnston, Army Medical Corps.
For conspicuous gallantry and devotion to duty during operations. When his battalion was relieved, he stayed behind to tend the wounded, and then went forward through a heavy enemy barrage and dressed a wounded officer and several other men in the front trench. He also tended others while returning under fire.
Capt. James Sprent, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire with great courage and determination. He personally supervised and organized the forward portion of tending the wounded right up to the firing line.
Capt. David MacDonald Steele, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire and trying conditions with great courage and determination. It was due to his organization and skill that the wounded men were successfully evacuated.
Capt. William Henry Weston, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He established an aid post in the open and tended the wounded under very heavy fire. He has displayed great cour and determination throughout.

Canadian Force.

Capt. Kenneth Edgar Cooke, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended the wounded for two days and nights, under intense fire, with great gallantry and ability.
Capt. Howard Brown Jeffs, Army Medical Corps.
For conspicuous gallantry and devotion to duty. Although wounded himself, he tended the wounded under very heavy fire with great courage and determination. Later, being again wounded, he remained on duty till relieved.
Capt. Victor Henry Kingsley Moorhouse, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire, displaying great courage and determination throughout.
Capt. Thomas Francis O'Hagan, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He rescued a wounded officer and five men under very heavy fire. Later, he tended the wounded in an advanced dressing station under heavy fire. He displayed great courage and determination throughout.
Capt. Alex. Harold Taylor, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire with great courage and ability. He has on many previous occasions displayed great bravery.
Capt. William Lawrence Whittemore, Army Medical Corps.
For conspicuous gallantry and devotion to duty. Although wounded, he carried out his duty with great courage and determination. He has on many previous occasions displayed great gallantry.
The undermentioned have been awarded a Bar to their Military Cross for subsequent acts of conspicuous gallantry :—
Temp. Capt. Cyril Mary Brophy, M.C., Royal Army Medical Corps.
For conspicuous gallantry in action. He tended a wounded officer under intense fire. Later, he carried out the work of rescuing the wounded with great courage and determination. He has on many previous occasions done fine work. (The Military Cross was awarded in *London Gazette*, dated July 27, 1916.)
Capt. John Arthur Cullum, M.C.Can., Army Medical Corps.
For conspicuous gallantry in action. He carried out the evacuation of the wounded under very heavy fire with great courage and skill, and at great personal risk. He has on many previous occasions done very fine work. (The Military Cross was awarded in *London Gazette*, dated July 27, 1916.)
Temp. Capt. William Foot, M.C., M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty in action. He tended the wounded without any regard for his own safety, and, by his coolness throughout the action,

undoubtedly saved many lives. (The Military Cross was awarded in *London Gazette*, January 14, 1916.)

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned Non-commissioned Officers and Men for acts of gallantry and devotion to duty in the field :—

No. 1679 Pte. F. Angell, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire, displaying great courage and determination. He was severely wounded.

No. 20478 Serjt. J. W. Hastings, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded under heavy fire, displaying great courage and determination. He has done fine work on many previous occasions.

No. 1089 Cpl. J. Henderson, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He assumed command of an aid post and carried out his work under very heavy fire with great skill and determination.

No. 49086 Pte. F. Hudson, Royal Army Medical Corps.

For conspicuous gallantry when carrying a wounded man through an area full of gas from shells. The man had no gas helmet, and Private Hudson, knowing the risk put his own helmet on the wounded man, and, although suffering himself from the gas, managed to carry him in.

No. 1621 Pte. G. Hunter, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He, accompanied by three stretcher-bearers, rescued a wounded man under very heavy fire. Later, he tended the wounded in the open with great skill and determination. He has previously done very fine work.

No. 1732 Pte. L. Lammirman, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He carried a wounded man on his back through a very heavy barrage fire, displaying great courage and devotion to duty.

No. 44732, Serjt. A. MacLean, Royal Army Medical Corps.

For conspicuous bravery and devotion in action, when he exhibited the greatest coolness and courage in supervising the evacuation of wounded, many times carrying them in himself on his back.

No. 53482 Serjt. R. R. S. Martin, Royal Army Medical Corps.

For conspicuous bravery and devotion to duty on many occasions when in charge of stretcher-bearers, leading them frequently through extremely heavy shell fire to and from the front line trenches, and exhibiting a coolness and courage which inspired confidence in all with him. He never relaxed his efforts until all the wounded had been evacuated.

No. 2003 Serjt. W. Pearce, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. When the advanced dressing station was being heavily shelled, he transferred the dressing station to another point, and reorganized the dressing and evacuating of the wounded. He displayed great courage and initiative throughout.

No. 38428 Serjt. F. Sullivan, Royal Army Medical Corps.

For conspicuous gallantry in action. He tended the wounded under very heavy fire, personally attending to over fifty cases, and displaying great courage and determination.

No. 1915 Serjt. J. W. Wood, Royal Army Medical Corps.

For conspicuous bravery and devotion during lengthy operations, when, although blown over and severely shaken by a shell, he remained in an open trench for thirty-six hours attending the wounded under very heavy shell fire. By his gallant efforts he was undoubtedly responsible for saving a large number of men.

The undermentioned has been awarded a Bar to his Distinguished Conduct Medal for subsequent acts of conspicuous gallantry :—

No. 5778 Cpl. H. Meakins, Royal Army Medical Corps.

For conspicuous gallantry in action. He tended and brought in the wounded under very heavy fire, displaying great courage and determination. Later, he organized and accompanied a search party. (The Distinguished Conduct Medal was awarded in the *London Gazette*, dated September 15, 1915, p. 9180.)

War Office,
November 16, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned non-commissioned officers and men:—

No. 32046 Pte. T. Ainsworth, Royal Army Medical Corps.
No. 48076 Pte. T. Allen, Royal Army Medical Corps.
No. 31803 Staff-Serjt. A. Baker, Royal Army Medical Corps.
No. 58203 Pte. (Acting-Cpl.) S. Battersby, Royal Army Medical Corps.
No. 46186 Pte. H. T. Beresford, Royal Army Medical Corps.
No. 385 Pte. E. N. Bradley, Royal Army Medical Corps.
No. 28 Pte. F. Castelow, Royal Army Medical Corps.
No. 57417 Serjt. J. McL. Donald, Royal Army Medical Corps.
No. 2194 Pte. (Acting-Lance-Cpl.) J. W. Downs, Royal Army Medical Corps.
No. 8762 Pte. E. J. Drage, Royal Army Medical Corps.
No. 64442 Pte. F. Fraser, Royal Army Medical Corps.
No. 205 Pte. A. Gott, Royal Army Medical Corps.
No. 47966 Serjt. A. Halliwell, Royal Army Medical Corps.
No. 1663 Lance-Cpl. O. Hamilton, Royal Army Medical Corps.
No. 74197 Pte. T. W. Hills, Royal Army Medical Corps.
No. 594 Pte. T. I. Hinchcliffe, Royal Army Medical Corps.
No. 48124 Serjt. T. G. Hopkins, Royal Army Medical Corps.
No. 41949 Serjt. A. E. Howson, Royal Army Medical Corps.
No. 39748 Pte. A. V. Hunt, Royal Army Medical Corps.
No. 39213 Serjt. J. Ingram, Royal Army Medical Corps.
No. 596 Serjt. J. W. Johnston, Royal Army Medical Corps.
No. 48584 Pte. W. H. Jones, Royal Army Medical Corps.
No. 6385 Acting-Cpl. C. C. B. Kirby, Royal Army Medical Corps.
No. 1691 Cpl. (Acting-Lance-Serjt.) W. E. Lambourne, Royal Army Medical Corps.
No. 1298 Pte. J. Latham, Royal Army Medical Corps.
No. 41759 Pte. J. Leigh, Royal Army Medical Corps.
No. 59247 Pte. J. Leitch, Royal Army Medical Corps.
No. 42244 Pte. C. Leyland, Royal Army Medical Corps.
No. 8859 Cpl. A. H. Lucas, Royal Army Medical Corps.
No. 1735 Serjt. P. Maury, Royal Army Medical Corps.
No. 39127 Pte. C. Mountfield, Royal Army Medical Corps.
No. 44705 Pte. D. Murdoch, Royal Army Medical Corps.
No. 48559 Pte. T. J. Nicholas, Royal Army Medical Corps.
No. 1867 Pte. W. E. Paddock, Royal Army Medical Corps.
No. 198 Pte. J. N. Partridge, Royal Army Medical Corps.
No. 48181 Pte. W. J. Ridgeway, Royal Army Medical Corps.
No. 38415 Serjt. W. A. Riley, Royal Army Medical Corps.
No. 1550 Pte. W. Robinson, Royal Army Medical Corps.
No. 4164 Pte. T. Sweeney, Royal Army Medical Corps.
No. 48514 Pte. D. Thomas, Royal Army Medical Corps.
No. 48909 Pte. E. B. Thomas, Royal Army Medical Corps.
No. 175 Serjt. C. S. Turner, Royal Army Medical Corps.
No. 30485 Pte. R. Vallance, Royal Army Medical Corps.
No. 1590 Pte. S. Waters, Royal Army Medical Corps.
No. 5973 Pte. E. R. Wheeler, Royal Army Medical Corps.
No. 64109 Acting-Cpl. S. Wormald, Royal Army Medical Corps.

THE GRAND PRIORY OF THE ORDER OF THE HOSPITAL OF ST. JOHN OF JERUSALEM IN ENGLAND.

November 18, 1916.

The King has been graciously pleased to sanction the following appointments to the Order of the Hospital of St. John of Jerusalem in England:—

AS KNIGHTS OF GRACE.

Col. Edward Horace Lynden Lynden-Bell, C.B., M.B., Royal Army Medical Corps.
Col. Sir Bertrand Edward Dawson, K.C.V.O., C.B., M.D., B.Sc., F.R.C.P.

ARMY MEDICAL SERVICE.

Col. Samuel Hickson, C.B., M.B., K.H.S., is retained on the Active List, under the provisions of Articles 120 and 522 Royal Warrant for Pay and Promotion, and to be supernumerary, dated November 14, 1916.

ROYAL ARMY MEDICAL CORPS.

The undermentioned Majors (Temporary Lieutenant-Colonels) relinquish their temporary rank on re-posting:—

Dated June 10, 1916.—Edward G. Anthonisz.

The undermentioned Lieutenant-Colonels to be Temporary Colonels whilst Assistant Directors of Medical Services of Divisions:—

Dated August 29, 1916.—Oliver L. Robinson, C.M.G.

Dated September 18, 1916.—Brian Watts.

Dated September 25, 1916.—Malcolm MacG. Rattray, M.B.

Lieut.-Col. (Temp. Col.) George S. McLoughlin, C.M.G., D.S.O., M.B., relinquishes the rank of Temp. Col. on re-posting, dated September 19, 1916.

Lieut-Col. John C. Connor, M.B., to be Temp. Col. whilst employed as Assistant Director of Medical Services of a Base, dated August 29, 1916.

Dated September 8, 1916.—Eugene Ryan, D.S.O.; William Wiley, M.B.

Major Reginald Storrs to be Temp. Lieut.-Col. whilst in command of a Casualty Clearing Station, dated September 9, 1916.

Major Eugene Ryan, D.S.O., to be Temp. Lieut.-Col. whilst specially employed, dated September 25, 1916.

Capt. (Temp. Major) Clarence H. Denyer relinquishes the rank of Temp. Major on re-posting, dated September 3, 1916.

The undermentioned to be Temporary Major whilst in command of a Field Ambulance:—

Capt. Charles L. Franklin, M.B., dated August 18, 1916.

ASTLEY COOPER PRIZE.

THE next triennial prize of £300, under the will of the late Sir Astley Cooper, Bart., will be awarded to the author of the best essay or treatise on "Gunshot Wounds of the Lungs and Pleura."

The conditions annexed by the testator are: "That the essays or treatises to be written for such prize shall contain *original experiments and observations*, which shall *not have been previously published*; and that each essay or treatise shall (as far as the subject shall admit of) be *illustrated by preparations and drawings*, which preparations and drawings shall be added to the Museum of Guy's Hospital, and shall, together with the work itself and the sole and exclusive interest therein and the copyright thereof, become henceforth the property of that Institution, and shall be relinquished and transferred as such by the successful candidate."

And it is expressly declared in the Will: "That no physician or surgeon, or other officer for the time being of Guy's Hospital or of St. Thomas's Hospital, in the Borough of Southwark, nor any person related by blood or affinity to any such physician or surgeon for the time being, or to any other officer for the time being in either of the said hospitals, shall at any time receive or be entitled to claim the prize."

The prize cannot be awarded to any essay which is the joint production of two or more authors; nor can it be awarded to any member of the hospital or school staff of either Guy's or St. Thomas's Hospital; but with the exceptions here referred to, this prize is open for competition to the whole world. No essay will be eligible for the prize unless it complies with *all* the conditions given above.

Candidates are informed that their essays, either legibly written or type-written in the English language, or, if in a foreign language, accompanied by an English translation, must be sent to Guy's Hospital, on or before January 1, 1919, addressed to the Physicians and Surgeons of Guy's Hospital, London, S.E.

Each essay or treatise must be distinguished by a motto, and accompanied by a sealed envelope containing the name and address of the writer. None of the envelopes will be opened except that which accompanies the successful treatise. The trustees will entertain the question of the publication of the successful essay in the following number of the Guy's Hospital Reports. This will not of itself preclude the successful competitor from publishing his essay elsewhere upon obtaining permission.

The unsuccessful essays or treatises, with the illustrative preparations and drawings, will remain at the Museum of Guy's Hospital until claimed by the respective writers or their agents.

C. H. FAGGE, M.S., *Hon. Sec.*,
Guy's Hospital.

ROYAL ARMY MEDICAL CORPS COMFORTS.

THE following donations have been received by Lady Sloggett's Comforts Fund from R.A.M.C. Units during the year 1916:—

Depot and No. 1 Company, R.A.M.C., Aldershot ..	£300	0	0
No. 35 Company, R.A.M.C., Millbank	80	0	0
Training Centre, R.A.M.C., Sheffield	60	0	0
,, ,, ,, Crookham	50	0	0
No. 7 Company, R.A.M.C., Devonport	30	0	0
Training Centre, R.A.M.C., Ripon	25	0	0
No. 30 Company, R.A.M.C., Malta	24	1	0
No. 6 Company, Cosham	21	0	0
No. 20 Company, Tidworth..	10	0	0
No. 10 Company, Chatham..	10	0	0
No. 19 Company, Chester	8	5	0
No. 17 Company, Curragh (in account book as No. 17 Company, Chester)	5	4	6
R.A.M.C., Cottonera	5	0	0
No. 32 Field Ambulance	5	0	0
No. 12 or 34 Company, Woolwich (which?)	5	0	0
No. 14 Company, R.A.M.C., Dublin..	5	0	0
Millbank Serjeants' Mess	5	0	0
No. 29 Company, R.A.M.C., Jamaica	4	0	0
Whalley Hospital Nursing Staff	3	10	0
No. 25 Company, Bermuda	3	3	0
No. 14 Company, Serjeants' Mess, Dublin	3	0	0
No. 18 Company, Edinburgh	2	2	0
No. 27 Company, Hong Kong	2	0	0
No. 27 Company, Hong Kong, Serjeants' Mess ..	2	0	0
No. 11 Company, R.A.M.C., Canterbury	2	0	0
R.A.M.C., Dublin, Portobello	1	10	0
Military Free Hospital	1	3	0
Total	£672	18	6

DEATH.

KELLY.—Lieutenant-Colonel J. F. M. Kelly, M.B., died at the Nurses' Home, Salisbury, on August 22, 1916.

DEATH VACANCY.—A very good class Practice for sale on the Thames. Receipts about £800. Excellent introduction. Small Panel. Great scope for surgery and increase of general practice. Premium by arrangement. House optional. Address, Box 50, c/o *Journal of the Royal Army Medical Corps*, 8, Serle Street, W.C.

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, and Proceedings of the United Services Medical Society.

Any demand for excerpts, additional to the above, or for reprints, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates:—

Number of Reprints	Number of Pages	Cost of Reprints	Cost of Excerpts *	Extra for Covers for Reprints: As Journal, Printed on Front	As Journal, Plain, Unprinted	Cheaper Paper, Printed on Front	Cheaper Paper, Plain, Unprinted
		£ s. d.	£ s. d.	s. d.	s. d.	s. d.	s. d.
12	4	0 2 9	0 1 2				
	8	0 5 0	0 2 3	4 8	1 1	3 10	0 9
	16	0 8 3	0 3 11				
25	4	0 3 4	0 1 5				
	8	0 6 0	0 2 9	4 10	1 6	4 4	0 11
	16	0 10 6	0 5 0				
50	4	0 4 6	0 1 10				
	8	0 7 6	0 3 6	6 0	2 1	4 10	1 2
	16	0 13 3	0 5 10				
100	4	0 6 0	0 3 1				
	8	0 10 0	0 4 10	7 10	3 11	6 7	2 5
	16	0 18 6	0 7 6				
200	4	0 9 6	0 4 5				
	8	0 15 0	0 6 7	10 10	7 6	9 0	4 10
	16	1 6 0	0 9 8				

* These are not arranged as Reprints, but appear precisely as in the Journal with any other matter that may happen to appear on the first and last pages of the particular excerpt ordered.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

All such Communications or Articles accepted and published in the "Journal of the Royal Army Medical Corps" will (unless the Author notifies at the time of submission that he reserves the copyright of the Article to himself) become the property of the Library and Journal Committee, who will exercise full copyright powers concerning such Articles.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," War Office, Whitehall, London, S.W.

Communications have been received from Captains Basil Hughes, P. W. Maclagan, W. E. Cooke, S. Mann; Lieutenant W. Roche; M. V. Shanahan, Esq.; Serjeant-Major E. B. Dewberry; Staff-Serjeant C. O. Dixon.

The following publications have been received:—

British: St. Bartholomew's Hospital Journal, Public Health, The South African Institute for Medical Research, The Hospital, The Lancet, The Journal of Tropical Medicine and Hygiene, Guy's Hospital Gazette, The Medical Press and Circular, Bulletin of Entomological Research, The Medical Journal of Australia, The Medical Entomology of Salonica, Transactions and the Annual Report of the London Dermatological Society, The R.A.M.C. Magazine, Journal of the Royal United Service Instiiution, Commonwealth of Australia, The Medical Journal of South Africa.

Foreign: Archives de Médecine et de Pharmacie Navales, The Journal of Infectious Diseases, Office International d'Hygiène Publique, The Military Surgeon, Archives de Médecine et de Pharmacie Militaires, Le Caducée, Bulletin of the Johns Hopkins Hospital, Bulletin de l'Institut Pasteur, Giornale di Medicina Militare.

MANAGER'S NOTICES.

. The JOURNAL OF THE ROYAL ARMY MEDICAL CORPS is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

THE HON. MANAGER,
"JOURNAL OF THE ROYAL ARMY MEDICAL CORPS,"
WAR OFFICE, WHITEHALL, S.W.